

A Generic Synopsis of the Poneroid Complex of the Family Formicidae in Japan (Hymenoptera). Part II. Subfamily Myrmicinae.

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Abstract

The ant subfamily Myrmicinae of Japan is revised at genus-level. Twenty six genera are treated. A key to the myrmicine genera in Japan are presented. Synonymic list, descriptions of all castes as possible and comment on each genus are given with illustrations. Morphological notes on fore wing venation and male genitalia of Myrmicinae are commented.

Introduction

This is the second part of the study on the taxonomy of the poneroid subfamily complex in Japan. In the first part of this study, a key to Japanese subfamilies was given and the genera of Ponerinae and Cerapachyinae were summerized (Ogata, 1987). The present part deals with 26 genera of Myrmicinae, including morphological comments and a key to the Japanese genera.

Since the publication of the first part, the knowledge on the Japanese ants has made rather rapid progress. The Myrmecological Society of Japan (MSJ) launched a project for identification manuals of species (1988, 1989, 1991; and still in progress). Although these publications are written in Japanese and they carefully avoid formal taxonomic changes, it would be helpful to estimate the number of species including undescribed or undetermined ones. Taxonomic papers on Japanese ants have increased over recent years. For example, revised notes on the Japanese *Myrmica* and *Hypoponera* were given by Onoyama (1989a, b); several new species were described by Terayama (1985a, b; 1987; 1988), Terayama &

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Ogata (1989), Terayama & Kubota (1989), Terayama & Satoh (1990), Ogata (1990); and many short reports on distribution and taxonomic changes have been published.

Furthermore, besides Japanese fauna, there have been reassessments of morphological characters at subfamily-level (cf. Bolton, 1990 a, b, c; Hashimoto, 1991a, b; Ward, 1990). These recent advances will lead to a change in the hypothesis on phylogenetic relationships of subfamilies. But the poneroid subfamily complex is still valid for its monophyly at the moment. The most comprehensive summary of the recent myrmecological study was given by Hölldobler & Wilson (1990).

As stated in the first part, the primary aim of this study is to show the present knowledge on the Japanese ant at genus-level. The need for identification of species in local fauna is increasing and urgent. But I also agree with the view that each genus should be revised separately in terms of the world-wide basis. Thus the present study does not include the isolate descriptions of new taxa but shows the present taxonomic framework. I also tried to describe reproductive castes as far as possible, which will contribute to the phylogenetic relationships of genera.

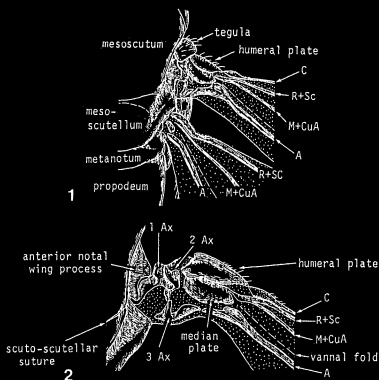
Morphological note

Myrmicines are one of the most diverse groups morphologically in ants. Since the form of workers is quite adaptive, sometimes it is difficult to infer the phylogenetic relationships of genera. In spite of the abundance of genera, there is little information on reproductive castes. In this section, some morphological structures of reproductive castes (female and male) are commented on, with discussions of their functions. This is also applicable to other subfamilies of Formicidae.

Fore wing venation (Figs. 1-5):

The importance of the wing venation as a taxonomic character has been noticed by several authors (cf. Brown & Nutting, 1949; Delago-Darchen, 1973). In the following discussion, as well as in the descriptions of the previous paper (Ogata, 1987), I follow the terminology of Ross (1935).

As pointed out by Snodgrass (1910), in recognizing homologies of veins, axillary sclerites and proximal plates are important. Figs. 1 and 2 show the right wing bases of ponerines, *Cryptopone sauteri* and *Brachyponera chinensis* respectively. The general pattern of this area is consistent through the family Formicidae. As shown in these figures, the 4th axillary sclerites is lost, and the 1st axillary sclerite does not articulate with any veins directly. Instead the 2nd axillary is interpolated between 1st axillary sclerite and the



Figs. 1-2. Right wing base: 1, *Cryptopone sauteri*, male; 2, *Brachyponera chinensis*, female, tegula removed.

median plate. The general connections are as follows: the vein *C* articulates with the humeral plate; the veins *R + Sc* and *M + CuA* fused proximally and articulate with the median plate; the vein *A* with the median plate and the 3rd axillary sclerite.

The fore wing venation is quite variable in the subfamily Myrmicinae. This is sometimes true even within a single species. According to Brown & Nutting (1949), the ancestral fore wing venation is diagrammatically shown in Fig. 3. The modifications of the veins mainly occur at the distal area posterior to the stigma (the enclosed area with broken line). Four venational patterns are distinguished according to the relative positions of the veins *Rs*, *M*, *CuA*, *Rs* and *r-m* (Fig. 4: the vein *A* is omitted).

Type I shows the primitive condition having five abscissae of the vein *M*. In the most primitive state of this type, the crossvein *1r* is present and the crossvein *cu-a* is situated distant from the diverging point of the longitudinal veins *M* and *CuA* (Brown & Nutting, 1949). Type I is seen in many ponerine genera, so that it has been often referred as "ponerine type".

Type II is characterized by the distal position of the diverging point of *Rs* from *M* comparing with that of *m-cu* from *M*. In this type two cubital cells are retained as in type I.

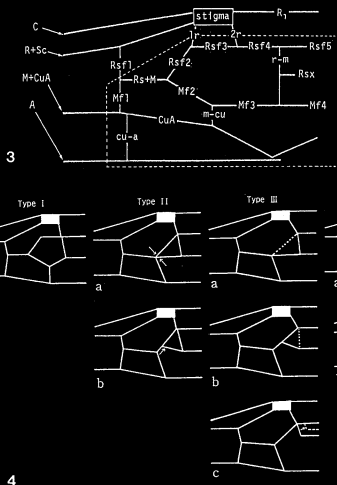


Fig. 3-4. Diagrams showing fore wing venation: 3, hypothetical ancestor of Formicidae (reduction of veins occurs in the area surrounded with broken line); 4, four types of fore wing venation.

There is a graded series from the constriction of *Mf2* (Fig. 4: type IIa) to the petiolate state of the second discoidal cell (Fig. 4: type IIb).

Type III bears only one cubital cell due to the loss of the veins *Rsf2*·3 (Fig. 4: type IIIa) or *r-m* (Fig. 4: type IIIb). When the remnant is completely absent, it is difficult to determine which vein is lost. Sometimes the diverging point of *r-m* from *Rs* (*M* from *r-m*) is distant from that of *2r* (Fig. 4: type IIIc).

Type IV is characterized by the absence of the distal portion of the vein *M*. In this type, the cubital cell is present (Fig. 4: type IVa) or absent (Fig. 4: type IVb) due to the loss of *Rs*+*M* and *Rsf2*·3. A extreme of this type is seen in *Leptanilla* of Leptanillinae, where only a single vein (*R*+*Sc*+*Rs*) is present.

Table 1. Fore wing venational types of some poneroid complex genera.

type		m-cu vein	radial cell	type		m-cu vein	radial cell
Ponerinae				Stenamma			
<i>Amblyopone</i>	I	+	close	II a, b; III a, b, c	+	open	
<i>Proceratium</i>	III	+/-	close/open	<i>Aphaenogaster</i>	II a, b	+	close/open
<i>Ectomomyrmex</i>	I	+	close	<i>Messor</i>	I; II a, b	+	open
<i>Brachyponera</i>	I	+	close	<i>Pheidole</i>	II a, b	+	open
<i>Cryptopone</i>	I	+	close	<i>Leptothorax</i>	IV a	-	open
<i>Ponera</i>	I	+	close	<i>Cardiocondyla</i>	IV a	-	open
<i>Hypoponera</i>	I	+	close	<i>Tetramorium</i>	III b, c	+/-	close/open
<i>Leptogenys</i>	I	+	close	<i>Solenopsis</i>	III b	+	open
<i>Odontomachus</i>	I	+	close	<i>Monomorium</i>	III b, c; VI a, b	+/-	open
Cerapachyinae				<i>Oligomyrmex</i>	III b	+	close
<i>Cerapachys</i>	I; IV b	+/-	open	<i>Vollenhovia</i>	IV a, b	-	open
Leptanillinae				<i>Lordomyrma</i>	III b	+	close
<i>Leptanilla</i>	IV (lacking most veins)			<i>Myrmecina</i>	III b	-	close
Myrmicinae				<i>Pristomyrmex</i>	III b	-	close
<i>Myrmica</i>	III a	+	open	<i>Crematogaster</i>	III b, c; IV a, b	+/-	open
<i>Manica</i>	III a	+	close/open	<i>Atta</i>	III b, c	-	close
				<i>Strumigenys</i>	IV b	-	open
				<i>Smithistruma</i>	IV b	-	open
				<i>Kyidris</i>	IV b	-	open
				<i>Epitritus</i>	IV b	-	open

In types III and IV, the loss of the crossvein *m-cu* often occurs. Although the type I shows relatively a primitive state and the type IV an advanced state in terms of a reduction series, these venational types do not represent an evolutionary sequence. We need not to suppose that a reduction of veins might have occurred through a single route. Rather they are convenient to describe the various venational patterns. Table 1 summarizes the venational patterns with the presence or absence of the *m-cu* crossvein and radial cell in poneroid genera so far examined.

Fig. 5 shows the relationship between the number of closed cells and wing length in the Myrmicinae. It is obvious that the smaller the wing size, the lower the cell number. Since the number of closed cells represents the degree of the reduction of veins, the venational pattern might be affected by wing size rather than the phylogenetic history in this subfamily. Because wings are principally a flight organ, it is most probable that they adapt to the aerodynamic forces. According to Weis-Fogh (1973), the flight pattern in minute insects is different from the flapping movement in larger insects. Because of the influence of relatively high air viscosity, minute insects show a clip-fling movement of wings, where the leading edge needs a supporting function for the flexible posterior areas. This is consistent with the conservative veins *C* and *R+Sc* and the reduction area as in Fig. 5. Thus it should be noted that the reduced venation in small ants does not always represent the same phylogenetic history.

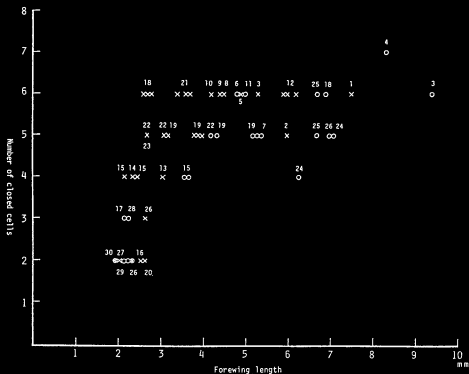


Fig. 5. Relationship between the number of closed cells of fore wing and fore wing length in myrmicine ants. 1, *Manica yessensis*; 2, *Myrmica kotokui*; 3, *Messor aciculatus*; 4, *Aphaenogaster* sp. (nr. *rothneyi*); 5, *Aphaenogaster famelica*; 6, *Stenamma* sp. 1; 7, *Stenamma* sp. 2; 8, *Pheidole megacephala*; 9, *Pheidole nodus*; 10, *Pheidole indica*; 11, *Pheidole pelti*; 12, *Tetramorium caespitum*; 13, *Tetramorium lanuginosum*; 14, *Leptothorax* sp.; 15, *Leptothorax congruus*; 16, *Cardiocondyla* sp. 1; 17, *Cardiocondyla* sp. 2; 18, *Oligomyrmex sauteri*; 19, *Solenopsis japonica*; 20, *Vollenhovia emeryi*; 21, *Lordomyrma azumai*; 22, *Myrmecina graminicola nipponica*; 23, *Pristomyrmex pungens*; 24, *Crematogaster laboriosa*; 25, *Crematogaster matsumurai*; 26, *Crematogaster osakensis*; 27, *Strumigenys lewisi*; 28, *Epitritus hexamerus*; 29, *Kydris mutica*; 30, *Smithistruma incerta*. (o: female; x: male).

Male Genitalia (Figs. 6-24):

I have already described the male genitalia of the genera of Ponerinae and Cerapachyinae in the previous part of this study (Ogata, 1987). Here I will make a brief comment on the structure of male genitalia as well as their function. Although the knowledge on the male genitalia at genus level is limited, the studies by Snodgrass (1941), Clausen (1934), Kempf (1956), Krafchick (1959) and Birket-Smith (1981) are available.

The terminology used in this paper is that of Snodgrass (1941) as in the previous paper. The corresponding terms of previous authors are shown in Table 2.

The male external genitalia consist of the basal supporting plate, or the basal ring, outer lateral lobes, or parameres, inner paired structure, or volsellae, and the median penis

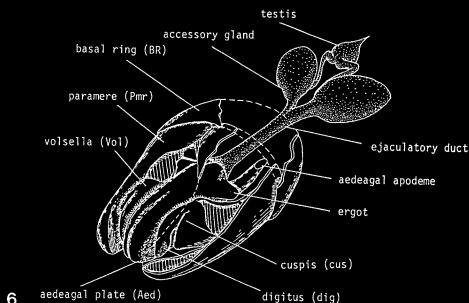


Fig. 6. Diagram showing male genitalia. Right dorsolateral walls of the basal ring and paramere partly removed.

Table 2. Terminology of male genitalia.

Snodgrass (1941)	Clausen (1938)	Michener (1966)	Smith (1970)		Birket-Smith (1981)
lamina annularis (or basal ring)	cardo	gonobase	gonocoxite IX	section 1 (or gonobase)	cupula
lamina paramerales (or basiparamere)	squamula	gonocoxite		section 2	stipite
volsella lamina volsellaris (or basivolsella) cuspis volsellaris digitus volsellaris	lacinia volsella	volsella cuspis digitus		section 3 (or volsella) cuspis digitus	volsella cuspis digitus
paramere	stipes	gonostylus	gonostylus		harpides
aedeagus lamina aedagalles (or penis valves) aedeagal apodeme ergot	sagitta spatha	penis penis valve apodeme of pv ergot	gonapophysis proximal rhachis ventral ramus dorsal ramus notum		thyrsos apodemata thyrsos ergot

covered by aedeagal plates (Fig. 6).

The basal ring is an annular sclerite, surrounding the genital foramen and this is variously developed with genera. Morphologically this is the proximal part of the gonopod, or gonocoxite, as pointed out by Smith (1969, 1970).

correspond to a gonocoxite and a gonostylus respectively. Thus the term paramere is applied to the whole outer lateral structure in this paper, as well as in the previous one. The ventroproximal projection is called gonocoxal arm, which is a synapomorphy of Myrmicinae.

The volsella is separated from paramere by a narrow membranous line or inner ridge.

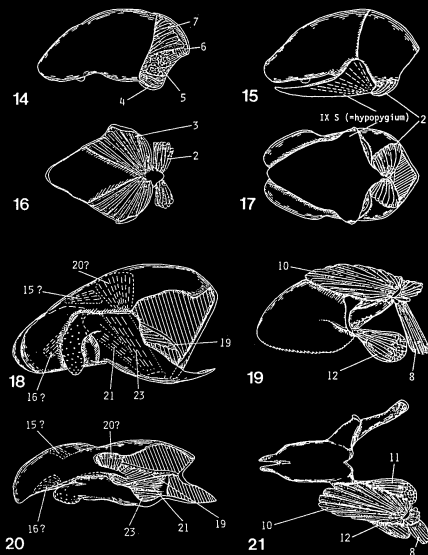
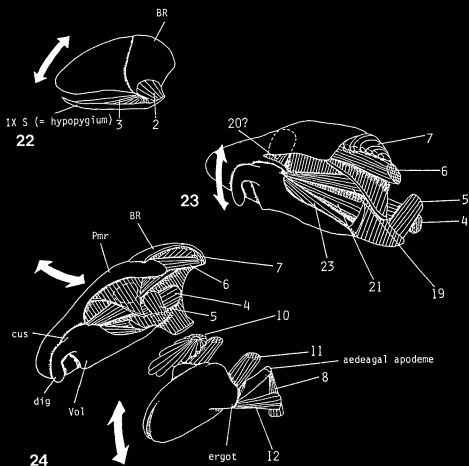


Fig. 14-21. Male genital muscles of *Myrmica kotokui*: 14, lateral view, right wall of the basal ring removed; 15, same, with a hypopygium; 16, hypopygium, dorsal view; 17, hypopygium and genital capsule, ventral view; 18, left paramere and volsella, inner view; 19, right aedeagal plate, lateral view; 20, left paramere and volsella, dorsal view; 21, aedeagal plate, dorsal view.

Primitively the apical portion of volsella has two lobes; the inner digitus and outer cuspis, the latter often being reduced in Myrmicinae.

The median penis consists of lateral paired aedeagal plates and the median endophallus. Aedeagal plates are often fused to each other dorsally, surrounding the endophallus, bearing two distinct processes; the proximal aedeagal apodeme and the lateral ergot. The shape of the aedeagal plate varies in genera of Ponerinae as shown in part I of this study, and this is also true for Myrmicinae, but in most cases it is armed with serrate ventral margin.

The principle musculature of the male genitalia is relatively consistent through the family, though some reductions occur. Figs. 14 to 21 show the male genital musculature of *Myrmica kotokui*, where muscle numbers follows those of Snodgrass (1941). The relative



Figs. 22-24. Diagram showing male genital musculature and inferred movements of genital components (arrows): 22, hypopygium and genital capsule; 23, right paramere and volsella; 24, right paramere, volsella and aedeagal plate.

position of each part of male and female genitalia in copulation are shown in Figs. 7 to 13. Based on these observations, the expected movements of each part of the male genitalia in copulation are inferred as in Figs. 22 to 24.

The parameres are used to clasp the female terminal portion, in particular the base of the 2nd valvifer and 2nd valvula. According to Peck (1937), the volsellae of ichneumonids wasps seize the conjunctival membrane of a female by pincer-like structure of digitus and cuspis, keeping it taut while the median penis is inserted to the female genitalia. In Formicidae, however, this seizing function of the volsellae may be lost or reduced, judging from the fact that the digitus and cuspis do not form the pincer-like structure. In many myrmicines the digitus or cuspis is reduced, or often completely lost as stated above. Instead the digitus probably serves as a sensory organ since it has many camponiform sensillae, while the ventral edge of volsellae depress the male hypopygium in copulation. The aedeagal plates are not only inserted into the female vagina, but also support the female genitalia from the ventral position of the female, where the serrate ventral margin of the aedeagal plate is considered to be useful. Thus the firm connection in copulation is mainly made by a clasping function by parameres and supporting function by the aedeagal plate. A similar mechanism was observed in *Bombus* by Kopelke (1981).

Subfamily Myrmicinae

Myrmicites Lepeleteir, 1863, Hist. Nat. Insect. Hymen. 1:169.

Myrmicidae Mayr, 1855, Verh. Zool.-Bot. Ver. Wien, 5:290.

Myrmicinae Dalla Torre, 1893, Cat. Hymen. 7:53.

Myrmecinae Bingham, 1903, Fauna Brit. India, Hym. 2:105.

Worker: Posterior margin of clypeus usually produced posteriorly between frontal carinae. Antennal insertions separated, usually covered by frontal lobes. Pronotum and mesonotum immovably connected, dividing suture impressed but often indistinct or completely absent. Propodeum sometimes with distinct paired projections posterodorsally. Tibial spurs on middle and hind poorly pectinate, simple or absent; basitarsus of hind leg without sulcus; claws of all legs simple. Abdominal pedicel 2-segmented. Sting variously developed, often reduced.

Female: Body size distinctly larger than worker. Eyes larger than those of worker. Ocelli always present. Trunk massive. Pronotum often overhung by mesoscutum which bears parapsidal furrows. Mesepisternum with oblique furrow. Epimeral lobe absent. Fore wing venation varying from type II to type IV; hind wing lacking anal lobe. Abdominal pedicel 2-segmented. Gaster massive. Remainder of body and appendages like those of worker.

Male: Antennal insertion exposed. Eyes large; inner margin not concave. Ocelli developed. Trunk massive. Pronotum usually overhung by mesoscutum as in female. Parapsidal furrows almost always present, notauli often impressed on mesoscutum. Mesepisternum with oblique furrow. Posterodorsal portion of propodeum sometimes with bluntly angled corners. Abdominal pedicel 2-segmented. Genitalia retractile; proximal portion of paramere with ventral gonocoxal arm.

This subfamily includes the largest number of genera (more than 140) in the Formicidae. Although the subfamily is morphologically diverse, it is a monophyletic group in having the following synapomorphic characters:

1. Frontal carinae are developed, covering antennal insertions though secondarily reduced in several genera.
2. The pronotum and mesonotum are fused to form an immovable connection even dividing the impressed suture.
3. The 3rd abdominal segment is isolated from the rest of gaster, forming a postpetiole in all castes.
4. The gonocoxal arms are present in the male genitalia.
5. The pupa is naked.

Kugler (1978a, b; 1979; 1986) studied the sting apparatus of Myrmicinae and proposed a hypothesis on the phylogenetic relationships between genera. But comprehensive reclassification at genus-group or tribe level has not been completed yet.

The genera treated in this paper are as follows:

- | | | |
|-------------------------|-----------------------------|--------------------------|
| 1) <i>Myrmica</i> | 10) <i>Strongylognathus</i> | 19) <i>Crematogaster</i> |
| 2) <i>Manica</i> | 11) <i>Monomorium</i> | 20) <i>Strumigenys</i> |
| 3) <i>Stenamma</i> | 12) <i>Solenopsis</i> | 21) <i>Quadristruma</i> |
| 4) <i>Aphaenogaster</i> | 13) <i>Oligomyrmex</i> | 22) <i>Smithistruma</i> |
| 5) <i>Messor</i> | 14) <i>Vollenhovia</i> | 23) <i>Pentastroma</i> |
| 6) <i>Pheidole</i> | 15) <i>Trigonogaster</i> | 24) <i>Trichoscapa</i> |
| 7) <i>Leptothorax</i> | 16) <i>Lordomyrma</i> | 25) <i>Kyidris</i> |
| 8) <i>Cardicondyla</i> | 17) <i>Myrmecina</i> | 26) <i>Epitritus</i> |
| 9) <i>Tetramorium</i> | 18) <i>Pristomyrmex</i> | |

In terms of myrmicine genera the Japanese ant fauna is characteristic in having a relative abundance of dacetine genera (Nos. 20–26 of above list). There are 2 more genera reported from Japan; *Pheidologeton* (MSJ, 1988) and *Rhopalomastix* (Terayama, 1985). Since I did not examine the Japanese specimens of both genera, they are not treated in this paper though they are in the key.

Key to the genera of Myrmicinae

(based on worker, applicable to Japanese species only)

1. Antennae with 6 segments or less; petiole and postpetiole with spongiform appendages2
- Antennae with 9 segments or more; petiole and postpetiole without spongiform appendages8
2. Mandibles linear, sometimes more or less curved medially, not serially dentate dorsally3
- Mandibles subtriangular, serially dentate dorsally 5
3. Labrum with anterior paired lobes visible between mandibular insertions in dorsal view *Epitritus*
- Labrum without anterior paired lobes 4
4. Head gently narrowed anteriorly; antennae 6-segmented *Strumigenys*
- Head abruptly narrowed at anterior 2/3; antennae 4-segmented *Quadristruma*
5. Mandibles with distinct basal margin, forming transverse basal border or gap when closed; pronotum marginate anteriorly forming squariform flattened area *Trichoscapa*
- Mandibles without basal margin; pronotum marginate anteriorly but not forming squariform flattened area, or not marginate6
6. Basal portion of mandibles, when closed, forming spaced area; lateral portion of postpetiole exposed, without spongiform appendage *Kyidris*
- Basal portion of mandibles, when closed, without open space; lateral portion of postpetiole covered with spongiform appendage7
7. Dorsum of head flattened; eyes situated anterior to the midlength of sides of head *Pentastruma*
- Dorsum of head convex; eyes situated posterior to the midlength to the sides of head *Smithistruma*
8. Postpetiole connected with dorsum of first gastral segment; propodeal spiracle situated close to posterior margin *Crematogaster*
- Postpetiole connected with basalmost portion of first gastral segment; propodeal spiracle situated more or less apart from posterior margin9
9. Propodeal spine curved anterodorsally and directed forward *Trigonogaster*
- Propodeal spine turned upward or backward, or absent10
10. Frontal lobes running close to each other *Rhopalomastix*
- Frontal lobes separated more or less widely11
11. Antennal club consisting of apical 2 segments12
- Antennal club consisting of 3 or more, or not formed14
12. Antennae 11-segmented *Pheidologeton*

- Antennae 9- to 10-segmented 13
- 13. Posterior declivity of propodeum marginate; posterodorsal portion of propodeum often with projections; dorsal surface of head, trunk, petiole and postpetiole sculptured; worker caste dimorphic **Oligomyrmex**
- Posterior declivity of propodeum not marginate; posterodorsal portion of propodeum unarmed; dorsal surface of body smooth and shining; worker caste monomorphic or polymorphic **Solenopsis**
- 14. Petiole cylindrical, with obliquely truncate anterior portion; dorsum of propodeum with small projections on anterior to base of propodeal spines **Myrmecina**
- Petiole nodiform; dorsum of propodeum simple without projections 15
- 15. Anterior margin of clypeus armed with small denticles **Pristomyrmex**
- Anterior margin of clypeus without small denticles 16
- 16. Mandibles blade-like, without denticles **Strongylognathus**
- Mandibles subtriangular, with denticles on masticatory margins 17
- 17. Anterior margin of clypeus produced over basal portion of mandibles; antennal scrobes deep, almost extending to posterior corners of head **Lordomyrma**
- Anterior margin of clypeus not produced over basal portion of mandibles; antennal scrobes shallow or absent 18
- 18. Antennal club consisting of 3 apical segments 19
- Antennal club consisting of 4 apical segments, or not formed 24
- 19. Lateral portion of clypeus raised into ridge in front of antennal insertion **Tetramorium**
- Lateral portion of clypeus simple, not forming ridge in front of antennal insertion 20
- 20. Posterodorsal portion of propodeum rounded or bluntly angulate, without projections **Monomorium**
- Posterodorsal portion of propodeum with a pair of spiniform or dentiform projections 21
- 21. Dorsum of head and trunk without standing hairs; occipital carina absent; postpetiole distinctly broad, nearly 2 x as broad as petiole **Cardiocondyla**
- Dorsum of head and trunk with more or less standing hairs; occipital carina present; postpetiole slightly broader than petiole 22
- 22. Promesonotal area raised; worker caste dimorphic **Pheidole**
- Promesonotal area depressed; worker caste monomorphic 23
- 23. Anterior portion of 1st gastral segment with rounded anterior corners **Leptothorax**
- Anterior portion of 1st gastral segment simply narrowed without anterior corners **Vollenhovia**
- 24. Subpetiolar process present 25
- Subpetiolar process absent 26
- 25. Propodeal spines long and acute **Myrmica**

- Propodeal spines absent **Manica**
- 26. Ventral surface of head with psammophre ;propodeal spines absent **Messor**
- Ventral surface of head without psammophore ;propodeal spines present 27
- 27. Eyes larger, longest diameter exceeding scape width ; antennal scape extending about 1/4 of its length or more beyond posterior margin of head **Aphaenogaster**
- Eyes smaller, longest diameter as long as or shorter than scape width ; antennal scape reaching or slightly extending beyond posterior margin of head **Stenammina**

Genus **Myrmica** Latreille

(Figs. 25-35)

Myrmica Latreille, 1804, Nouv. Dict. Hist. Nat. 24 : 175. Type species: *Formica rubra* Linnaeus, 1758, Syst. Nat. ed.10 : 580, by subsequent designation of Latreille, 1810, Considerations generales sur l'ordre naturel...: 437.

Sifolinia Emery, 1907, Rend. R. Accad. Sci. Ist. Bologna 11 : 49. Type species: *Sifolinia laurae* Emery, 1907, loc. cit., by monotypy.

Sommimyrmica Menozzi, 1925, Atti Soc. Nat. Mat. Modena (6) 8 : 25. Type species: *Sommimyrmica symbiotica* Menozzi, 1925, loc. cit., by original designation.

Symbiomyrmica Arnoldi, 1930, Zool. Anz. 91 : 267. Type species: *Symbiomyrmica karavajevi* Arnoldi, 1930, loc. cit., by monotypy.

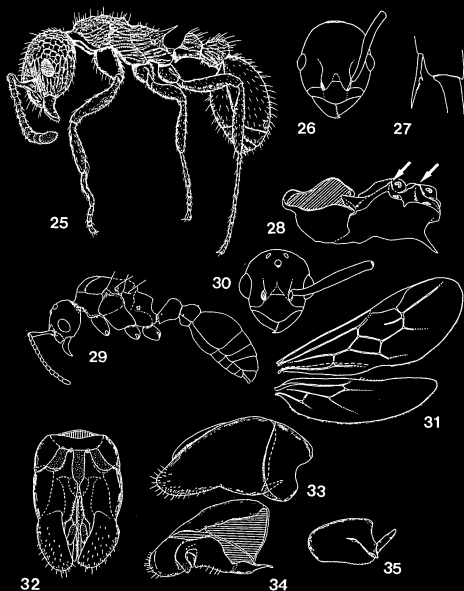
Paramyrmica Cole, 1957, J. Tennessee Acad. Sci. 32 : 37. Type species: *Paramyrmica colax* Cole, 1957, loc. cit., by original designation.

Dodecamyrmica Arnoldi, 1968, Zool. Zh. 47 : 1803 (as subgenus of *Myrmica*). Type species: *Myrmica arnoldii* Dlussky, 1963, Ent. Ob. 42 : 194, by original designation.

Worker: Head almost oval in frontal view, with narrow transverse posterior border; occipital carina low. Mandibles broadly subtriangular; masticatory margin with less than 10 denticles. Palp formula 6, 4. Clypeus broad, more or less convex in the middle; anterior margin widely rounded; posterior margin roundly produced between frontal carinae; anterolateral portions in front of antennal insertions sometimes forming ridge or carina. Frontal carinae short, covering antennal insertions, and diverging at the level of eyes. Antennae 12-segmented; scape usually extending beyond posterior border of head with more or less strongly curved base where outer fringe is developed in some species; funiculus incrassate, but not forming distinct club. Eyes prominent, moderate in size, situated anterior on the midlength of side of head.

Trunk rounded anteriorly; promesonotal suture indistinct dorsally; promesonotal region slightly raised; metanotal groove more or less distinct; propodeum with a pair of

long spines posterodorsally. Ventral process present on both meso- and metasterna. Legs long; middle and hind tibiae usually each with a single pectinate spur. Petiole nodiform with anterior peduncle; subpetiolar process present as small tooth anteroventally. Postpetiole subglobular. Gaster with developed sting apically.



Figs. 25-35. *Myrmica kotokui*, (25-28, worker; 29-35, male): 25, profile; 26, head; 27, left hind tibial spur; 28, trunk, ventro lateral view, arrows indicating ventral processes; 29, profile; 30, head; 31, right wings; 32, male genitalia, ventral view; 33, same, lateral view; 34, same, left paramere; 35, right aedeagal plate.

Female: General form of head like that of worker, with larger eyes and distinct ocelli. Pronotum overhung by mesoscutum; mesonotum somewhat flat dorsally; notauli absent, parapsidal furrows present on mesonotum; mesoscutellum partly overhanging metanotum; propodeal spines well developed as in worker. Epimeral lobe absent. Fore wing venation type I with modification where R_{5+6} vein is incompletely present; hind wing lacking anal lobe. Remainder of body, including legs, petiole, postpetiole and gaster like those of worker.

Male: Head subglobose, with low but distinct occipital carina. Mandibles developed, subtriangular in form, with dentate masticatory margin. Palp formula 5.3. Clypeus large, convex in the middle; anterior margin rounded; posterior margin produced between frontal carinae. Frontal carinae short, partly covering antennal insertions which are situated close to posterior margin of clypeus. Frontal area distinct, triangular in form and concave between frontal carinae and median posterior border of clypeus. Antenna 13-segmented; scape usually long, extending beyond posterior border of head; funiculus thick, incrassate. Eyes large and prominent; inner margin not concave.

Pronotum smaller, overhung by mesoscutum; both notauli and parapsidal furrows distinctly impressed; mesonotum flat dorsally; mesoscutellum overhanging metanotum; propodeum without long spines, but with angulate posterodorsal corners. Epimeral lobe absent. Fore and hind wings as in female. Ventral processes reduced to small tooth on both meso and metasterna. Legs as in worker, but pectination of tibial spurs more distinct. Petiole and postpetiole large and distinct with rounded nodes. Genitalia retractile; basal ring broader than long; paramere with distinct gonocoxal arm and rounded apex; inner wall of paramere bearing distinct oblique ridge ventrolaterally; volsella with large lobate digitus and small lamellate cuspis; aedeagal plate subtriangular with rounded apex in lateral view.

This holoarctic genus contains about 70 species (Collingwood, 1979). Revisionary studies of the genus include those of Weber (1947, 1948, 1950a) for the North American species, Collingwood (1958) for the British species, and Arnoldi (1976a) for the Middle Asian species.

Accepting the redefinition of the genus by Bolton (1988), the pectinate tibial spurs on the middle and hind legs become less important as a diagnostic character of the genus because they show a graded sequence of reduction from well pectinate to simple spinous conditions or even absent. This is also true for Japanese species.

In Japan the taxonomy of the genus has been confused. Onoyama (1980) listed 8 forms from Japan. But MSJ (1988) distinguished 6 species, including 2 undetermined and the following 4 named species:

Myrmica jessensis Forel

M. kurokii Forel

M. kotokui Forel

M. rubra (Linnaeus)

According to MSJ list (1988), the following are thought to be doubtful in the taxonomic status: *M. kascenkoi* Ruzsky, *M. kurokii sontica* Santschi, *M. rubra* var. *silvestrii* Wheeler, *M. rubra yoshiokai* Weber. Furthermore, MSJ omitted the following records due to doubtful identifications: *M. lobicornis* Nylander, *M. ruginodis* Nylander, *M. scabrinodis* Nylander. Although they provisionally concluded the species formerly identified as *ruginodis* to be *kotokui*, further study is required.

The distribution and distinguishing characters of *rubra* from *kotokui* were reported by Onoyama (1989). The southernmost record of the genus is that from Yakushima Is. (Terayama & Yamane, 1984), though it was identified as *M. ruginodis*.

Genus **Manica** Jurine

(Figs. 36-44)

Manica Jurine, 1870, Nouv. Meth. Class. Hym. 276 (as subgenus of *Myrmica*). Type species:

Formica rudia Latreille, 1802, Hist. Nat. Formis, Paris: 267, by subsequent designation of Wheeler, 1911, Ann. N.Y. Acad. Sci. 21: 166.

Manica Jurine; Weber, 1947, Ann. Ent. Soc. Amer. 40: 439. (Raised to genus.)

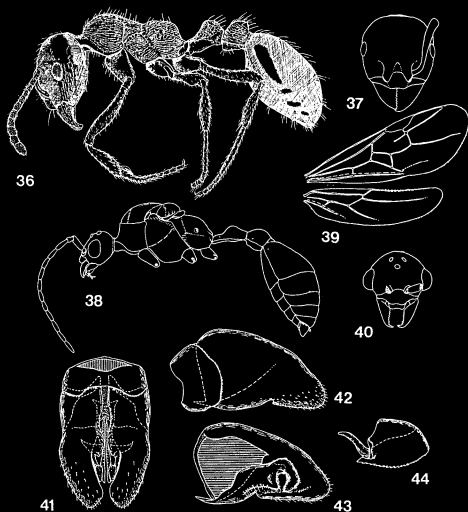
Neomyrma Forel, 1914, Rev. Suisse Zool. 22: 275 (as subgenus of *Aphaenogaster*). Type species: *Aphaenogaster (Neomyrma) calderoni* Forel, 1914, loc. cit., by monotypy.

Oreomyrma Wheeler, 1914, Psyche 21: 118 (as subgenus of *Myrmica*). Type species:

Formica rubida Latreille, 1802, Hist. Nat. Formis, Paris: 267, by original designation.

Worker: Head nearly oval with narrow flat posterior border; occipital carina low. Mandibles broad, subtriangular with dentate masticatory margin which consists of large apical tooth and more than 10 minute denticles. Palp formula 6.4. Clypeus large apical margin rounded, slightly emarginate medially in Japanese species.; posteriorly produced between frontal carinae. Frontal region more or less distinctly impressed. Frontal carinae short, covering antennal insertions. Antennae 12-segmented; scape reaching posterior corner of head, strongly curved at its base, in Japanese species; funiculus incrassate, but not forming definite segmental club. Eyes medium in size, situated on the midlength of sides of head.

Promesonotal area slightly raised; promesonotal suture absent dorsally; metanotal groove deeply impressed; propodeum without spines posterodorsally, but forming angulate corners. Ventral processes present as small teeth on both meso- and metasterna. Middle and hind legs each with a single spur which is less pectinate in Japanese species.



Figs. 36-44. *Manica yessensis*, (36-37, worker; 38-44, male): 36, profile; 37, head; 38, profile; 39, right wings; 40, head; 41, male genitalia, ventral view; 42, same, lateral view; 43, right paramere; 44, left aedeagal plate.

Petiolar node with rounded crest; subpetiolar process low, with angulate anteroventral corner. Postpetiole subglobose. Gaster with developed sting apically.

Female: General form of head as in worker with larger eyes and developed ocelli. Mesonotum somewhat flat dorsally; mesoscutum not overhanging pronotum; notauli absent in Japanese species, parapsidal furrows present; mesoscutellum partly overhanging metanotum; propodeum with rounded node and angulate posterodorsal corners. Fore wing with modified type III venation with $R_{sf} 2 \cdot 3$ incompletely present as in most *Myrmica* species; m-cu present; radial cell open or closed. Postpetiole with small median

projection anteroventrally. Remainder of body like those of worker.

Male: Head subglobose, with low occipital carina. Mandibles well developed, subtriangular; masticatory margin dentate, consisting of larger apical tooth and fine denticles. Palp formula 6,4. Clypeus transverse; anterior margin emarginate medially in Japanese species. Antennal insertions close to posterior margin of clypeus, not covered by frontal carinae. Antennae 13-segmented: scape short, not reaching posterior corner of head in Japanese species; funiculus filiform, incrassate, but not forming segmental club. Eyes large; inner margin not concave. Ocelli present.

Pronotum overhung by mesoscutum; notauli and parapsidal fur rows impressed on mesoscutum; mesoscutellum slightly convex dorsally, overhanging metanotum; propodeum large with rounded node; posterodorsal portion of propodeum lacking definite spines but with rounded corners. Epimeral lobe absent. Ventral processes low. Tibial spurs of middle and hind legs as in worker. Petiole pedunculate, with low and rounded node; subpetiolar process absent in Japanese species. Postpetiole globose as in worker. Hypopygium with distinct median projection basely, and with rounded apex. Genitalia retractile; basal ring broader than long; paramere with distinct gonocoxal arm posteroventrally and with rounded apex; volsella angulate posteroventrally, with longer digitus and smaller cuspis; aedeagal plate subtriangular with rounded apex in lateral view.

The genus includes 6 species, 2 of which are found in the Palearctic and 4 are in the Nearctic regions. The Nearctic species were revised by Wheeler & Wheeler (1970).

In Japan the genus has been represented by a single species:

Manica yessensis (Azuma)

This is the only species of the genus distributing in the eastern Palearctic region. Another Palearctic species (*M. rubida*) is found in western Europe. The Japanese species occurs in rather high elevation of grassland of volcanic mountains in Hokkaido and Honshu.

Genus **Stenamma** Westwood

(Figs. 45-52)

Stenamma Westwood, 1840, *Introduct. Mod. Class. Ins.*, Supl. 2 : 83. Type species : *Stenamma westwoodii* Westwood, 1840, *op. cit.* : 226, by monotypy.

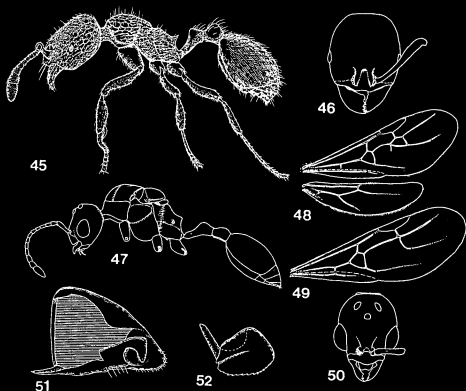
Asemorphoptrum Mayr, 1861, *Die Europäischen Formiciden* : 76. Type species : *Myrmica lippula* Nylander, 1849, *Act. Soc. Sc. Fennicae*, 3 : 41, by monotypy.

Theryella Santschi, 1921, *Bull. Soc. Hist. Nat. Afr. Nord*, 12 : 68. Type species : *Theryella*

myops Santschi, 1921, loc. cit., by monotypy.

Worker: Head subrectangular with slightly convex sides and with weakly concave or straight posterior border. Mandibles large, subtriangular; masticatory margin dentate with 2 or 3 larger apical teeth followed by 4 to 6 smaller denticles. Palp formula 4,3. Clypeus narrow, transverse, with a pair of longitudinal carinae; median portion of anterior margin emarginate. Frontal carinae short, not reaching the level of eyes, covering antennal insertions. Frontal region impressed between frontal carinae. Antenna 12-segmented; scape short, not reaching posterior corner of head; funiculus incrassate, but not forming definite segmental club. Eyes medium to small, situated nearly at the midlength of sides of head.

Promesonotal area raised, without suture; metanotal groove distinctly impressed; propodeum with a pair of teeth posterodorsally. Ventral processes absent on mesosternum, but present on metasternum in Japanese species. Middle and hind tibiae lacking



Figs. 45-52. *Stenamma ovestoni*. (45-46, worker; 47-52, male): 45, profile; 46, head; 47, profile; 48, right wings; 49, right fore wing showing intraspecific variation; 50, head; 51, right paramere of male genitalia; 52, left aedeagal plate.

distinct apical spurs; pretarsal claws of all legs simple. Petiole with long and narrow peduncle anteriorly; node low, subtriangular in lateral view; subpetiolar process lacking. Postpetiole much shorter than petiole with rounded node. Sting small.

Female: General form of head as in worker, with larger eyes and small ocelli. Pronotum not overhung by mesoscutum, with rounded humeri; mesonotum convex dorsally; notauli absent but parapsidal furrows present in Japanese species; mesoscutellum overhanging metanotum; propodeum vertically raised, without dorsal surface, but with distinct paired teeth posterodorsally.

Fore wing venation varying from type II to IV. Mesepisternum with oblique furrow. Ventral processes and legs as in worker. Petiole, postpetiole and gaster like those of worker but more massive.

Male: Head subglobose, longer than broad, with low occipital carina. Mandibles developed, subtriangular; masticatory margin dentate with 3 or 4 teeth. Palp formula 4,3. Clypeus narrow, transverse; anterior margin slightly produced in the middle in Japanese species. Frontal carinae short, low but distinct, not covering antennal insertions which are close to posterior margin of clypeus. Antennae 13-segmented; scape short, not reaching posterior corner of head; funiculus filiform. Eyes large and prominent; inner margin not concave. Ocelli present.

Pronotum relatively small. Mesonotum flat dorsally, overhanging both pronotum and metanotum; notauli and parapsidal furrows impressed on mesoscutum; propodeum without dorsal surface; posterodorsal corners of propodeum varying from obtuse lobes to dentiform projections, even within the species. Petiole and postpetiole like those of worker but with more rounded and lower nodes.

Hypopygium with a distinct mesal projection basally and rounded apex. Genitalia retractile; basal ring broader than long; paramere with distinct gonocoxal arm and rounded apex; volsella with long and down-curved digitus, lacking cuspis; aedeagal plate short, subtriangular, with rounded apex in lateral view.

This genus contains about 30 species, distributed in the Holarctic region. Revisionary studies of the genus include those of M.R. Smith (1957) for the species of America North of Mexico, Snelling (1973) for the species of western United States, Kutter (1971) for the species of western Europe, Arnoldi (1975) for the species of USSR, Baroni Urbani (1977) for the northern Indian species and Yasumatsu & Murakami (1960) for the Japanese species.

The genus has been represented by 2 species in Japan:

Stenamma nipponense Yasumatsu & Murakami

S. owstoni Wheeler

Both the species are rather rare, nesting in soil. The southern most record is Yakushima Island of *S. nipponense* by Terayama & Yamane (1984). Kubota (1988:23-24) reported a

seed storing habit of *S. owstoni*. According to him, a chamber of the nest was filled with the seed of *Clethra barbinervis* Sieb. et Zucc.

Genus **Aphaenogaster** Mayr

(Figs. 53-61)

Aphaenogaster Mayr, 1853, Verh. Zool.-Bot. Ver. Wien 3 : 107. Type species : *Aphaenogaster sardoa* Mayr, 1853, loc. cit., by subsequent designation of Bingham, 1903, Fauna Brit. India, Hym. 2 : 270.

Deromyrma Forel, 1913, Zool. Jb. Syst. 36 : 49 (as subgenus of *Ischnomyrmex* Mayr). Type species : *Aphaenogaster (Ischnomyrmex) swammerdami* Forel, 1886, Cr. Soc. Ent. Belg. 30 : 56, by monotypy.

Planimyrmica Viehmeyer, 1914, Zool. Jb. Syst. 37 : 604 (as subgenus of *Aphaenogaster*). Type species : *Stenamma (Ischnomyrmex) loriai* Emery, 1897, Ann. Mus. Stor. Nat. Genova, 38 : 563, by original designation.

Attomyrma Emery, 1915, Bull. Soc. Vaud. Sci. Nat. 50 : 70 (as subgenus of *Aphaenogaster*). Type species : *Formica subterranea* Latreille, 1798, Essai sur l'histoire des fourmis de la France : 49, by original designation.

Novomessor Emery, 1915, Rc. Sess. Accad. Sci. Ist. Bologna, 19 : 73. Type species : *Aphaenogaster (Ischnomyrmex) cockerelli* André, 1893, Revue Ent. 12 : 150, by original designation.

Nystalomyrma Wheeler, 1916, Trans. R. Soc. S. Aust. 40 : 215 (as subgenus of *Aphaenogaster*). Type species : *Myrmica longiceps* F. Smith, 1858, Cat. Hym. Brit. Mus. 6 : 128, by original designation.

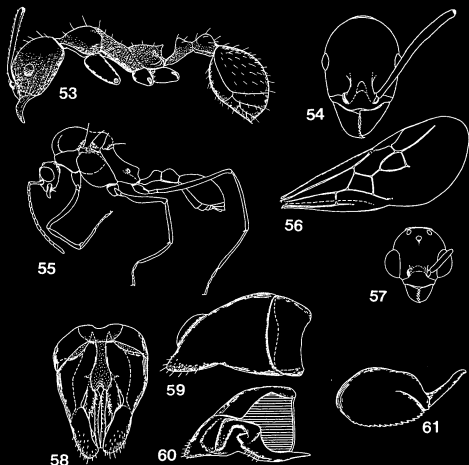
Brunella Forel, 1917, Bull. Soc. Vaud. Sci. Nat. 51 : 234. Type species : *Aphaenogaster (sic) belti* Forel, 1895, Ann. Soc. Ent. Belg. 39 : 248, by original designation.

Worker : Head oval, longer than broad ; posterior border rounded or narrowly straight, with distinct occipital carina. Mandibles large, subtriangular ; masticatory margin dentate, with 2 larger apical teeth followed by small denticles. Palp formula 5, 3 (in all Japanese species) or 4, 3. Anterior margin of clypeus rounded, sometimes shallowly emarginate in the middle. Frontal region impressed. Frontal carinae short, not reaching the level of eyes, covering antennal insertions partly. Antennae 12-segmented ; scape long, extending beyond posterior border of head ; funiculus incrassate, sometimes apical 4 segments forming indistinct club. Eyes prominent, medium in size, situated almost at midlength of sides of head.

Trunk slender with raised promesonotal region ; promesonotal suture indistinct ;

metanotal groove deeply impressed; propodeum with paired dentiform projections posterodorsally. Ventral processes absent on meso- and metasternum. Legs long and slender; middle and hind tibiae each with a simple small spur apically. Petiole with long peduncle anteriorly; node subtriangular with more or less rounded crest in lateral view; subpetiolar process usually absent. Postpetiole globular; anterior margin narrower than posterior one. Sting reduced.

Female: General form of head as in worker; antennal scape relatively shorter than that of worker; eyes large; ocelli present. Trunk massive, distinctly high; pronotum small, completely overhung by mesoscutum; mesonotum large and thick, slightly convex dorsally; notauli absent but parapsidal furrows present on mesoscutum; mesoscutellum



Figs. 53-61. *Aphaenogaster famelica*. (53-54, worker; 55-61, male): 53, profile; 54, head; 55, profile; 56, right fore wing; 57, head; 58, male genitalia, ventral view; 59, same, lateral view; 60, left paramere; 61, right aedeagal plate.

overhanging metanotum; propodeal spines more distinct, longer and stouter than those of worker. Fore wing venation type II or rarely III; m-cu present; radial cell closed or open. The remainder of body and appendages like those of worker, but more massive.

Male: Head small, subrectangular with rounded posterior corners and low occipital carina. Mandibles usually broad, subtriangular; masticatory margin dentate. Palp formula 5.3 in Japanese species. Clypeus produced anteriorly; anterior margin rounded, sometimes slightly emarginate in the middle. Frontal carina indistinct, short and low. Antennal insertions exposed, close to posterior margin of clypeus. Antenna 13-segmented; scape short, not reaching posterior margin of head at least Japanese species; funiculus filiform, incrassate. Eyes large and prominent; inner margin not concave. Ocelli well developed.

Trunk slender; pronotum small, completely overhung by mesonotum; mesonotum massive; mesoscutum convex dorsally with notauli and parapsidal furrows; mesoscutellum convex, overhanging metanotum; propodeum usually long and narrow, sometimes distinctly elongate, constricted just anterior to propodeal spiracle; propodeal spines reduced to form obtuse lobes. Fore wing venation as in female. Legs long and slender; middle and hind tibiae each with a small simple spur. Petiole and postpetiole like those of worker but lower and more rounded nodes.

Basal ring thin; paramere with distinct gonocoxal arm and rounded apex; volsella projected posteroventrally; digitus slender, curved ventrally; cuspis small, lamelliform; aedeagal plate rounded apically, with simple serrate ventral margin in lateral view.

More than 80 species are included in the genus. The distribution of the genus is world wide except for the Ethiopian and the southern Neotropical regions, most species occur in the temperate zone. The latest synonymic list of the genus was given by Bolton (1982) who also commented on the venation. The New Guinean fauna was studied by M.R. Smith (1961), and the species of USSR was studied by Arnoldi (1976b), but most of the species remain unstudied.

Onoyama (1980) listed 4 species with 4 infraspecific forms. Two species and two subspecies of *famelica* described by Wheeler in 1928 (*A. vapidula*, *A. verecunda*, *A. famelica frontosa*, *A. famelica rudia*) have never been reported except for the original ones, and thus thought to be junior synonyms of *famelica* and/or *japonica* by Japanese myrmecologists, but the formal taxonomic treatment have not been done. MSJ (1988) provisionally excluded these names from Japanese fauna, and recognized 7 species including 3 undetermined ones.

In addition, Nishizono & Yamane (1990) newly described a subspecies of *famelica* from the Ryukyus. Thus we have 9 nominated taxa of the genus but the status of each should be reviewed based on more extensive material.

Aphaenogaster famelica (F. Smith)

A. famelica erabu Nishizono & Yamane

A. famelica frontosa Wheeler

A. famelica rudia Wheeler

A. osimensis Teranishi

A. smythiesi japonica Forel

A. tipuna Forel

A. vapidula Wheeler

A. verecunda Wheeler

A karyological study of 3 Japanese species, *A. famelica*, *A. japonica* and *A. oshimensis* was made by Imai (1971).

Genus **Messor** Forel

(Figs. 62-70)

Messor Forel, 1890, Cr. Soc. Ent. Belg. 34 : 118 (as subgenus of *Aphaenogaster* Mayr). Type species: *Formica barbara* Linnaeus, 1767, Syst. Nat. ed. 13 : 962, by subsequent designation of Bingham, 1903, Fauna Brit. India, Hym. 2 : 277.

Messor Forel; Bingham, 1903, Fauna Brit. India, Hym. 2 : 277. (Raised to genus.)

Cratomyrmex Emery, 1891, Ann. Soc. Ent. Fr. 60 : 572. Type species: *Cratomyrmex regalis* Emery, 1891, loc. cit. by monotypy.

Veromessor Forel, 1917, Bull. Soc. Ent. Fr. 1917 : 235 (as subgenus of *Novomessor* Emery).

Type species: *Aphaenogaster andrei* Mayr, 1886, Verh. Zool. Bot. Ges. Wien, 36 : 448, by subsequent designation of Emery, 1921, Gen. Ins. 174 : 67.

Veromessor Forel; Wheeler, 1922, Bull. Amer. Mus. Nat. Hist. 45 : 680. (Raised to genus.)

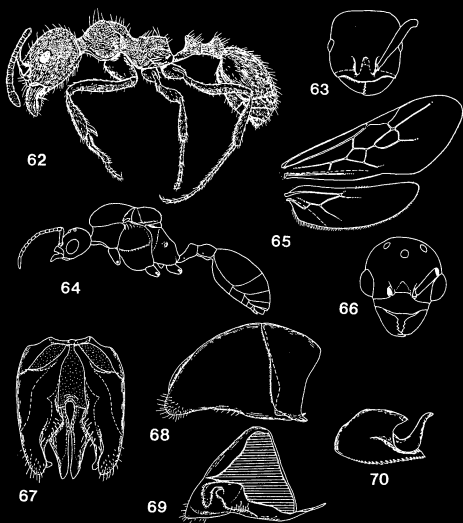
Lobognathus Enzman, 1947, J. N.Y. Ent. Soc. 55 : 152 (as subgenus of *Veromessor*). [Erroneous entry for *Veromessor lobognathus* (Andrews); see Brown, 1949, Psyche 56 : 49].

Worker: Usually strongly polymorphic, but less so in Japanese *aciculatus*. Head subrectangular, almost as broad as or broader than long, with rounded posterior corners; occipital carina present; ventral surface psammophore. Mandibles large, subtriangular; masticatory margin dentate. Palp formula 4.3 (in Japanese species) or 5.3. Clypeus narrow; anterior margin straight or slightly emarginate in the middle; posterior margin roundly produced between frontal carinae which do not reach the level of eyes and partially cover antennal insertions. Antennae 12-segmented; scape slender, reaching posterior corner of head in Japanese species; funiculus incrassate, not forming segmental club. Eyes moderate to large, situated at or just behind the midlength of sides of head.

Promesonotal area raised; promesonotal suture present as arched impression in dorsal view; metanotal groove more or less deeply impressed; posterodorsal portion of propodeum usually not forming definite spines but rounded corners. Ventral processes

present on both meso- and metasternum. Middle and hind tibiae each with two simple spurs apically. Petiole with narrow anterior peduncle; node subtriangular in lateral view; subpetiolar process absent. Postpetiole with rounded node. Sting reduced.

Female: General form of head as in worker, with larger eyes and small ocelli. Trunk massive; mesonotum thick, flat or slightly convex dorsally; mesoscutum overhanging pronotum; notauli absent, parapsidal furrows impressed on mesoscutum; mesoscutellum overhanging metanotum; propodeum with short and arched node, and with a pair of obtuse lobes posterodorsally. Fore wing venation type II or III; m-cu vein present; radial cell



Figs. 62-70. *Messor aciculatus*, (62-63, worker; 64-70, male): 62, profile; 63, head; 64, profile; 65, right wings; 66, head; 67, male genitalia, ventral view; 68, same, lateral view; 69, left paramere; 70, right aedeagal plate.

open. Ventral processes present on meso- and metasternum. Legs stout; tibial spurs on middle and hind legs like those of worker. Remainder of body like those of worker, but more massive.

Male: Head subglobose, longer than broad, with short and flat posterior border; occipital carina low but distinct. Mandibles narrowly triangular; masticatory margin dentate, with 4 teeth in Japanese species. Palp formula 3,2. Clypeus produced anteriorly; anterior margin straight or slightly convex. Frontal carina indistinct. Antennal insertions exposed, situated close to posterior margin of clypeus. Antennae 13-segmented; scape short, only reaching posterior margin of eye; funiculus filiform, incrassate. Eyes large and prominent; inner margin not concave. Ocelli well developed.

Trunk massive; pronotum relatively small, overhung by mesoscutum; notauli absent at least in Japanese species, but parapsidal furrows impressed on mesoscutum; meso-scutellum overhanging metanotum; propodeum with narrow node, and with obtuse angled corners posterodorsally. Fore wing like that of female. Ventral processes present on both meso- and metasternum. Legs long and slender; middle and hind tibiae each with a single simple spur apically. Petiole and postpetiole like those of worker, but with lower and more rounded nodes.

Hypopygium pentagonal; basal margin with distinct projection medially; apex rounded. Genitalia retractile; basal ring thick; paramere with distinct gonocoxal arm posteroventrally, tapering toward apex; digitus slender, curved ventrally; cuspis small; aedeagal plate with rounded apex and simple serrate ventral margin in lateral view.

The genus contains about 90 species, most of which are distributed in the Palearctic region, and some are found in the Ethiopian region. The recent faunal revisions includes those of Arnoldi (1977a) for USSR, Collingwood (1978) for the Iberian Peninsula, and Bolton (1982) for the Ethiopian region. The last includes the generic synonymy. The species of this genus are known as harvester ants, nesting in the soil of open land and collecting seeds.

In Japan, the genus has been represented by a single species:

Messor aciculatus Forel

This species is found from northern Honshu to Kyushu. The detailed biology has been studied by Onoyama (1981a, b; 1982a, b) and Onoyama & Abe (1982).

Genus **Pheidole** Westwood

(Figs. 71-80)

Pheidole Westwood, 1841, Ann. Mag. Nat. Hist. 6 : 87. Type species: *Atta providens* Sykes,

- 1835, Trans. Ent. Soc. Lond. 1 : 103, by subsequent designation of Bingham, 1903, Fauna Brit. India, Hym. 2 : 220.
- Oecophthora* Heer, 1852, Hausameise Madeirans : 15. Type species : *Oecophthora pusilla* Heer, 1852, loc. cit., by monotypy.
- Ischnomyrmex* Mayr, 1862, Verh. Zool.-Bot. Ges. Wien, 12 : 738. Type species : *Myrmica longipes* F.Smith, 1857, J. Proc. Linn.
- Leptomyrma* Motschulsky, 1863, Bull. Soc. Imp. Nat. Moscou, 36 : 17. Type species : *Leptomyrma gracilipes* Motschulsky, 1863, loc. cit., by monotypy.
- Pheidolacanthinus* F.Smith, 1864, J. Proc. Linn. Soc. Lond., 8 : 75. Type species : *Pheidolacanthinus armatus* F.Smith, 1864, loc. cit., by original designation.
- Ceratopheidole* Pergande, 1895, Proc. Calf. Acad. Sci. 5 : 889 (as subgenus of *Pheidole*). Type species : *Pheidole (Ceratopheidole) granulata* Pergande, 1895, op. cit. : 890, by monotypy.
- Phidole* Bingham, 1903, Fauna Brit. India Hym. 2 : 220 (emend.)
- Epipheidole* Wheeler, 1903, Bull. Amer. Mus. Nat. Hist. 19 : 664. Type species : *Epipheidole inquilina* Wheeler, 1903, loc. cit., by monotypy.
- Sympheidole* Wheeler, 1904, Bull. Amer. Mus. Nat. Hist. 20 : 7. Type species : *Sympheidole elecebra* Wheeler, 1904, loc. cit., by monotypy.
- Phidola* Schulz, 1906, Spolia Hym. : 155 (emend.).
- Allophidole* Forel, 1912, Mem. Soc. Ent. Belg. 19 : 237 (as subgenus of *Pheidole*). Type species : *Pheidole kingi* André, 1898, Bull. Soc. Ent. Fr. (1898) : 244, by subsequent designation of Wheeler, 1913, Ann. N. Y. Acad. Sci. 23 : 79.
- Decapheidole* Forel, 1912, Mem. Soc. Ent. Belg. 19 : 237 (as subgenus of *Pheidole*). Type species : *Pheidole perpusilla* Emery, 1894, Bull. Soc. Ent. Ital. 26 : 157, by subsequent designation of Wheeler, 1913, Ann. N. Y. Acad. Sci. 23 : 79.
- Isopheidole* Forel, 1912, Rev. Suisse Zool. 20 : 765. Type species : *Myrmica longipes* F.Smith, 1857, J. Proc. Linn. Soc. Lond. 2 : 70, by original designation.
- Elasmopheidole* Forel, 1913, Zool. Jb. Syst. 36 : 43. Type species : *Pheidole aberrans* Mayr, 1868, Annuor. Soc. Natural Modena 3 : 172, by subsequent designation of Emery, 1922, Gen. Ins. 174 : 111.
- Cardiopheidole* Wheeler, 1914, J. N.Y. Ent. Soc. 22 : 48. Type species : *Pheidole vasliti* Pergande, 1895, Proc. Calf. Acad. Sci. (2) 5 : 883, by original designation.
- Macropheidole* Emery, 1915, Bull. Soc. Ent. Fr. (1915) : 190. Type species : *Pheidole fimbriata* Roger, 1863, Berl. Ent. Z. 7 : 196, by original designation.
- Scrobopheidole* Emery, 1915, Bull. Soc. Ent. Fr. (1915) : 190, (as subgenus of *Pheidole*). Type species : *Pheidole scrobifera* Emery, 1896, Bull. Soc. Ent. Ital. 28 : 73, by original designation.
- Stegopheidole* Emery, 1915, Bull. Soc. Ent. Fr. (1915) : 190, (as subgenus of *Pheidole*). Type species : *Pheidole (Elasmopheidole) upeneci* Forel, 1913, Zool. Jb. Syst. 36 : 43, by monotypy.
- Trachypheidole* Emery, 1915, Bull. Soc. Ent. Fr. (1915) : 190, (as subgenus of *Pheidole*).

Type species: *Pheidole bicornis* Forel, 1899, Biol. Centr.-Amer. 3 : 74, by original designation.

Parapheidole Emery, 1915, Rend. Accad. Sci. Ist. Bologna 1914-15 : 68. Type species: *Aphaenogaster oculata* Emery, 1900, Bull. Soc. Ent. Ital. 31 : 276, by monotypy.

Electropheidole Mann, 1921, Bull. Mus. Comp. Zool. Harv. 64 : 438 (as subgenus of *Pheidole*). Type species: *Pheidole (Electropheidole) roosevelti* Mann, 1921, loc. cit., by subsequent designation of Donisthorpe, 1943, Ann. Mag. Nat. Hist. (11) 10 : 642.

Cephalomorium Forel, 1922, Rev. Suisse Zool. 30 : 91 (as subgenus of *Tetramorium*). Type species: *Tetramorium (Cephalomorium) bahai* Forel, 1922, loc. cit., by monotypy.

Hendecapheidole Wheeler, 1922, Amer. Mus. Nov. 96 : 3 (as subgenus of *Pheidole*). Type species: *Pheidole tachigaliae* Wheeler, 1922, loc. cit., by original designation.

Gallardomyrma Bruch, 1932, Rev. Mus. La Plata, 33 : 271. Type species: *Gallardomyrma argentina* Bruch, 1932, op. cit. : 273, by original designation.

Conothorax Karawajew, 1935, Treubia 15 : 75. Type species: *Conothorax bilobum* Karawajew, 1935, loc. cit., by monotypy. [Nom. preoc., nec. Jekel, 1854-Coleoptera, Curculionidae.]

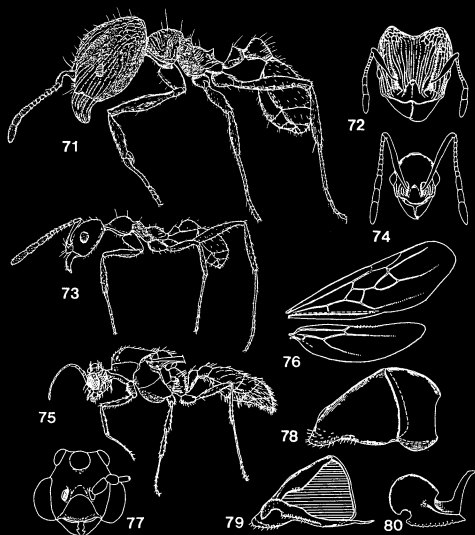
Conothoracoides Strand, 1935, Folia Zool. Hydrobiol. 3 : 176. [Nom. substit., pro. *Conothorax* Karawajew, 1935.]

Eriopheidole Kusnezov, 1952, Mem. Mus. Entre Rios, 29 : 5. Type species: *Eriopheidole symbiotica* Kusnezov, 1952, op. cit. : 16, by original designation.

Worker: Worker caste dimorphic, consisting of major (soldier) and minor (worker, s.str), usually not connected by intermediates.

Major worker — Head massive, longer than broad; posterior border emarginate in the middle, and forming paired occipital lobes; occipital carina absent. Mandibles large, subtriangular; masticatory margin with 2 large apical teeth and one basal tooth. Palp formula 2.2. Clypeus narrow, anterior margin slightly emarginate in the middle in Japanese species. Anteroventral margin of cranium with one or two pairs of small processes. Frontal carinae usually distinct, but their length varying with species reaching or exceeding the level of eyes, with or without antennal scrobes. Antennal insertions covered by frontal lobes. Antennae 12-segmented; scape not extending beyond posterior corner of head; apical 3 segments of funiculus forming distinct club. Eyes small to medium, situated anterior to the midlength of sides of head.

Promesonotal area raised; promesonotal suture indistinct or absent in dorsal view; metanotal groove impressed; propodeal spines present varying in size and shape with species. Ventral processes of meso- and metasternum absent. Legs stout; middle and hind tibiae each with a short and simple spur apically. Petiole nodiform, with rather slender anterior peduncle; node subtriangular in lateral view; subpetiolar process absent. Postpetiolar node rounded, usually bituberculate in dorsal view. Sting reduced.



Figs. 71-80. *Pheidole* spp., (71-72, major worker; 73-74, minor worker; 75-80, male); 71, *P. nodus*, profile; 72, same, head; 73, same, profile; 74, head; 75; *P. megacephala*, profile; 76, same, right wings; 77, same, head; 78, same, male genitalia, lateral view; 79, same, left paramere; 80, same, right aedeagal plate (from Ogata, 1982).

Minor worker — Head oval to subrectangular; posterior border rounded or flat; occipital carina variously developed from distinct fringe to almost absent in median area. Mandibles subtriangular; masticatory margin with two or three larger apical teeth followed by minute denticles. Palp formula 2.2. Anterior margin of clypeus widely rounded in Japanese species. Anteroventral margin of cranium without processes. Frontal carinae

short, without antennal scrobes. Antennae as in major worker, but scapes relatively longer, usually exceeding beyond posterior corners of head. Eyes large and prominent.

Trunk as in major worker, but with less raised and more rounded promesonotal area and with smaller propodeal spines. Legs as in major worker. Petiole and postpetiole more slender than those of major worker.

Female: Head subtriangular, with rounded posterior corners and straight or slightly concave posterior border. Mandibles, palp formula, clypeus and anteroventral margin of cranium like those of major worker. Antennae as in major worker, but scapes relatively shorter. Eyes large. Ocelli small but distinct.

Trunk massive; pronotum overhung by mesoscutum; mesonotum depressed with flattened dorsal surface; notauli absent, parapsidal furrow impressed on mesoscutum; mesoscutellum completely overhanging metanotum; propodeum small, without definite dorsal surface; propodeal spines shorter but robuster than those major worker. Fore wing venation type II. Mesepisternum with distinct oblique furrow. Ventral processes on meso- and metasternum absent. Remainder of body and appendages like those of major worker, but more massive.

Male: Head globular, almost as long as broad, much smaller than trunk; occipital carina distinct. Mandibles small and narrow; masticaroty margin with one apical acute tooth and 3 or 4 basal teeth. Palp formula 2,2. Clypeus convex in the middle; anterior margin straight or widely rounded. Frontal carina indistinct. Antennal insertions exposed, situated close to posterior margin of clypeus. Antennae 13-segmented; scape short, not reaching outer margin of eye; funiculus filiform, second funicular segment (= third antennal segment) short and broad, globular. Eyes large and prominent; inner margin not concave. Ocelli well developed, large and distinct.

Trunk massive; pronotum small overhung by mesoscutum; mesonotum thick, slightly convex dorsally; notauli absent; parapsidal furrows impressed on mesoscutum; mesoscutellum overhanging metanotum; propodeum with short dorsal surface; propodeal spines reduced, forming obtuse lobes. Fore wing as in female. Ventral processes absent. Legs long and slender; middle and hind tibiae each with a small simple spur apically. Petiole and postpetiole with low and rounded nodes.

Hypopygium pentagonal, with median basal projection and rounded apex. Genitalia retractile; basal ring short; paramere with distinct gonocoxal arm and rounded apex; digitus lobate, curved ventrally; cuspis absent; aedeagal plate variously concave anteroventrally, serrate ventral margin.

This is one of the largest genera in ants. The total number of species is estimated over 1000 (Brown, pers. comm.). The distribution range of the genus is world wide, and abundant in tropical and subtropical areas. The taxonomy of the genus is confused. The generic synonymy listed above was adopted from Brown (1973), who treated all the

subgenera as synonyms. Brown (1981) also gave a preliminary revision of some Neotropical and widely distributed species.

In Japan, the genus was revised by Ogata (1982) and 7 species were listed:

Pheidole fervens F. Smith

P. fervida F. Smith

P. indica Mayr

P. megacephala (Fabricius)

P. nodus F. Smith

P. pieli Santschi

P. ryukyensis Ogata

In addition, MSJ (1988) recognized another undetermined species. The ants of the genus are abundant in southern Japan. Males of some species are distinguished by the shape of the aedeagal plate.

The Japanese species are divided into two groups: one includes *fervens*, *indica*, *megacephala* and *nodus*, which are characteristic in having longer antennal clubs, rounded posterior margin of head in minor workers, and widely separated ventral processes of the cranium in major workers; the other includes *fervida*, *pieli* and *ryukyensis*, which are characteristic in having shorter antennal clubs, flat posterior margin of head in minor workers, and closely situated ventral processes of the cranium in major workers. The former group nests in rather open land, while the latter group in forest floor or in rotten wood. Recent studies on the biology of several species include Ito & Higashi (1990) on soldier reproduction of *P. fervida*; Magata & Yamane (1989) on recruitment pattern of *P. indica*; Ono (1984) on soldier reproduction of *P. fervida*; Tsuji (1990) on nutrient storage in *P. ryukyensis*; Yano & Yamane (1990) on the division of labour.

Genus **Leptothorax** Mayr

(Fig. 81-88)

Leptothorax Mayr, 1855, Verh. Zool.-Bot. Ver. Wien, 5 : 431. Type species: *Formica acervorum* Fabricius, 1793, Ent. Syst. 2 : 358, by subsequent designation of Bingham, 1903, Fauna Brit. India, Hym. 2 : 214.

Temnothorax Mayr, 1861, Die Europaischen Formiciden:68. Type species: *Myrmica* (*Lieptothorax*) *recedens* Nylander, 1856, Ann. Sci. Nat. (Zool.) (4) 5 : 94, by monotypy.

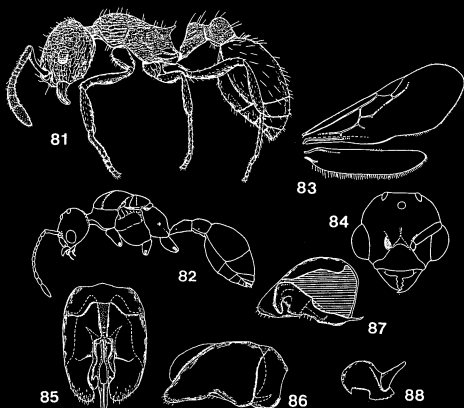
Dichothorax Emery, 1895, Zool. Jb. Syst. 8 : 323 (as subgenus of *Leptothorax*). Type species: *Leptothorax* (*Dichothorax*) *pergandei* Emery, 1895, loc. cit., by subsequent designation of Wheeler, 1911, Ann. N. Y. Acad. Sci. 21 : 161.

Goniothorax Emery, 1896, Bull. Soc. Ent. Ital. 28 : 58 (as subgenus of *Leptothorax*). Type

- species: *Leptothorax vicinus* Mayr, 1887, Verh. Zool.-Bot. Ges. Wien, 36 : 620, by subsequent designation of Wheeler, 1911, Ann. N. Y. Acad. Sci. 21 : 161. [Nom. preoc., nec. Milne-Edwards, 1897 — Crustacea.]
- Mychothorax* Ruzsky, 1904, Zap. Imp. Russk. Geogr. Obshch. Geogr. 41 : 288 (as subgenus of *Leptothorax*). Type species: *Formica acervorum* Fabricius, 1793, Ent. Syst. 2 : 358, by original designation.
- Nesomyrmex* Wheeler, 1910, Bull. Amer. Mus. Nat. Hist. 28 : 259, (as subgenus of *Leptothorax*). Type species: *Nesomyrmex clavipilis* Wheeler, 1910, loc. cit., by monotypy. [Nom. substit., pro. *Goniothorax* Emery, 1896; see M.R. Smith, 1950, Psyche 57 : 30.]
- Tetramyrma* Forel, 1912, Rev. Suisse Zool. 20 : 766 (as subgenus of *Dilobocondyla* Santschi). Type species: *Dilobocondyla (Tetramyrma) braunsi* Forel, 1912, op. cit. : 767, by monotypy.
- Caulomyrma* Forel, 1914, Bull. Soc. Vaud. Sci. Nat. 50 : 233 (as subgenus of *Leptothorax*). Type species: *Leptothorax echinatinodis* Forel, 1886, Cr. Soc. Ent. Belg. 34 : 48, by original designation.
- Myrmammophilus* Menozzi, 1924, Atti Soc. Nat. Mat. (6) 8 : 29 (as subgenus of *Leptothorax*). Type species: *Leptothorax (Myrmammophilus) finizii* Menozzi, 1924, loc. cit., by monotypy.
- Limnomyrmex* Arnold, 1948, Occ. Pap. Natn. Mus. Sth. Rhod. 14 : 222. Type species: *Limnomyrmex stramineus* Arnold, 1948, op. cit. : 223, by original designation.
- Myrafant* M.R. Smith, 1950, Psyche 57 : 29 (as subgenus of *Leptothorax*). Type species: *Leptothorax curvispinosus* Mayr, 1866, Sber. Akad. Wiss. Wien 53 : 508, by original designation.
- Icothorax* Hamann & Klemm, 1967, Ann. Nat. Mus. Wien 70 : 415 (as subgenus of *Leptothorax*). Type species: *Leptothorax (Icothorax) megalops* Hamann & Klemm, 1967, op. cit. : 417, by monotypy.

Worker: Head subrectangular, with rounded posterior corners and low occipital carina. Mandibles subtriangular; masticatory margin usually with 5 teeth. Palp formula 5.3. Clypeus narrow; anterior margin roundly projected; anterolateral portion not forming raised ridge in front of antennal insertion. Frontal carinae indistinct, anteriorly forming frontal lobes which cover antennal insertions. Antennal scrobes absent. Antennae 11- or 12-segmented in Japanese species; scape not extending posterior border of head; apical 3 segments forming club. Eyes moderate to large in size, situated at or slightly anterior to the midlength of sides of head.

Promesonotal region not raised; promesonotal suture absent dorsally; metanotal groove developed in various degree from shallowly to deeply impressed, or completely absent; propodeal spines present, but their shape varying with species from small dentiform to long and acute spines. Ventral processes of meso- and metasternum absent. Legs short; middle and hind tibiae without distinct spurs apically; claws small and simple. Petiole nodiform; anterior peduncle short; subpetiolar process small, situated anteroventally.



Figs. 80-88. *Leptothorax* spp. (81, worker; 82-88, male) : 81, *L. sp.*, profile; 82, *L. congruus*, profile; 83, same, right wings; 84, same, head; 85, same, male genitalia, ventral view; 86, same, lateral view; 87, same, left paramere; 88, same, right aedeagal plate.

Postpetiole small, usually compressed anteroposteriorly. Sting less developed, simple without apical lamelliform appendage.

Female: General form of head as in worker, with larger eyes and small ocelli. Pronotum overhung by mesoscutum; mesonotum flattened dorsally; notauli absent, parapsidal furrows indistinct; mesoscutellum not overhanging metanotum; propodeal spines varying in shape with species as in worker. Fore wing with type IV venation; stigma small or indistinct; m-cu absent; radial cell open; hind wing lacking most veins. Legs, petiole, postpetiole and gaster like those of worker.

Male: Head small and subglobose, with low occipital carina. Mandibles narrow; masticatory margin dentate with one acute apical tooth followed by small denticles. Palp formula 5,3. Clypeus convex in the middle, projecting anteriorly; anterior margin widely rounded; anterolateral portion not forming carina; median portion of posterior margin produced posteriorly. Frontal carina indistinct. Antennal insertion exposed, close to

posterior margin of clypeus. Antennae 13-segmented; scape short, not extending beyond outer margin of eyes; apical 4 segments of funiculus forming club. Eyes large and prominent. Ocelli well developed.

Mesonotum overhanging pronotum; notauli and parapsidal furrows impressed on mesoscutum; mesoscutellum convex, not overhanging metanotum; propodeal spines varying in shape, usually more obtuse than those in conspecific worker. Wings as in female. Ventral processes absent as in worker and female. Legs long and slender; apical spurs on middle and hind tibiae like those of worker. Petiole with more rounded and lower node than worker, lacking subpetiolar process. Postpetiole like that of worker.

Hypopygium longer than broad. Genitalia retractile; basal ring thin; paramere with small gonocoxal arm and rounded apex; digitus sharply curved ventrally; cuspis reduced to small thin lamella; aedeagal plate with emargination at posteroventral portion and serrate ventral margin.

The genus is world wide in distribution, with most being found in the Holoarctic region, including over 200 species (Bolton, 1982). Some regional revisions include those of Creighton (1950) for North America, Kempf (1959) and Baroni Urbani (1978) for Neotropical, Bernard (1968) and Collingwood (1979) for the western European, Arnoldi (1977b) for USSR and Bolton (1982) for Afrotropical species.

In Japan, the genus has been represented by the following 5 named species;

Leptothorax acervorum (Fabricius)

L. arimensis Azuma

L. congruus F. Smith

L. koreanus Teranishi

L. spinosior Forel

Additionally, several species, though undetermined, are known to occur (MSJ, 1988). Terayama & Satoh (1990b) recently examined the syntypes of *spinosior* and raised it to species rank which was formerly a variety of *congruus*. The genus nests in soils, under stones or in hollows of twigs.

Genus *Cardiocondyla* Emery

(Figs. 89-94)

Cardiocondyla Emery, 1869, Annali Accad. Aspir. Nat. Naspoli (2)2: 20. Type species:

Cardiocondyla elegans Emery, 1869, loc. cit., by monotypy.

Emeryia Forel, 1890, Cr. Soc. Ent. Belg. 34: cx. Type species: *Emeryia wroughtonii* Forel, 1890, op. cit. cxi, by monotypy.

Xenometa Emery, 1917, Bull. Soc. Ent. Fr. 1917 : 96. Type species: *Xenometa monilicornis* Emery, 1917, loc. cit. by monotypy.

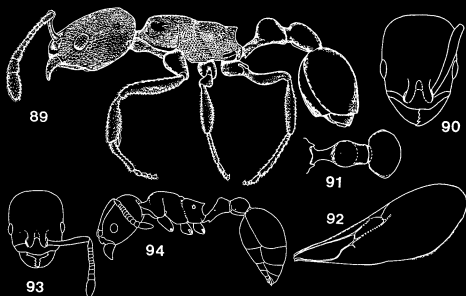
Loncyda Santschi, 1930, Rev. Suiss. Zool. 37 : 70 (as subgenus of *Cardiocondyla*). Type species: *Cardiocondyla (Loncyda) monardi* Santschi, 1930, loc. cit., by monotypy.

Dyclona Santschi, 1930, Rev. Suiss. Zool. 37 : 70 (as subgenus of *Cardiocondyla*). Type species: *Monomorium cristatum* Santschi, 1912, Ann. Soc. Ent. Belg. 56 : 163, by original designation.

Prosopidris Wheeler, 1935, Psyche 47 : 40 (as subgenus of *Cardiocondyla*). Type species: *Cardiocondyla (Prosopidris) sima* Wheeler, 1935, op. cit. : 41, by original designation.

Worker: Head subrectangular, longer than broad, with rounded posterior corners; occipital carina absent. Mandibles subtriangular; masticatory margin with 5 teeth in Japanese species. Palp formula 5.3. Clypeus narrow; anterior margin projection forward over basal margin of mandibles; anterolateral portion in front of antennal insertions not forming carina. Frontal carinae short or indistinct, at most reaching the level of eyes; anteriorly forming small frontal lobes which cover antennal insertions. Antennae 12-segmented in Japanese species, but rarely 11-segmented in exotic species; scape not extending beyond posterior border of head; apical 3 segments forming club. Eyes medium to large, situated anterior to the midlength of sides of head.

Trunk somewhat depressed, without raised promesonotal area; promesonotal suture



Figs. 89-94. *Cardiocondyla* sp. (nr. *nuda*). (89-91, worker; 92, female; 93-94, ergatoid male) : 89, profile; 90, head; 91, petiole and postpetiole, dorsal view; 92, right fore wing; 93, head; 94, profile.

absent dorsally; metanotal groove shallow or indistinct; propodeal spines varying with species, from obtuse teeth to acute spine-like. Ventral processes of meso- and metasternum absent. Legs short; apical spurs of middle and hind tibiae absent. Petiole nodiform, with narrow anterior peduncle; subpetiolar process present on anteroventral portion as small projection. Postpetiole with flattened node, much broader than petiole. Sting developed without lamelliform appendage.

Standing hairs on body and appendage absent.

Female: General form of head as in worker, with larger eyes and small ocelli. Pronotum not overhung by mesoscutum; mesonotum thin in lateral view, and flattened dorsally; notauli absent, parapsidal furrows present, but sometimes short or indistinct; mesoscutellum not overhanging metanotum; propodeal spines varying in shape as in worker. Fore wing venation type IV, stigma indistinct; hind wing almost lacking veins with long marginal hairs. Remainder of body and appendages like those of worker.

Male: In some species ergatoid male present in addition to normal winged form.

Ergatoid male: General form of head like that of worker. Mandibles varying from long and acute blade without teeth to subtriangular form with teeth. Clypeus with rounded anterior margin, which is sometimes emarginate in the middle. Antennal insertions and frontal carinae like those of worker. Antennae 11- or 12-segmented; scape as in worker; apical portion of funiculus sometimes forming club. Eyes medium to large. Ocelli absent. Trunk as in worker, with more angulate humeri; sometimes metanotum isolated as small transverse hump dorsally. Legs like those of worker. Petiole and postpetiole as in worker. Genitalia not dissected.

Winged male: Unknown to me.

The genus includes about 40 species, mostly distributed in the Old World tropics and subtropics (Bolton, 1982). Some species are widely spread in North America and Pacific islands by human introduction. Regional revisions include those of M.R. Smith (1944) for the North American, Bernard (1956) for the western Palearctic, Bolton (1982) for the Ethiopian, and Wilson & Taylor (1967) for the Oceanic species. The males of some species were revised by Kugler (1983).

In Japan at least 3 species have been known to occur. In his check list, Onoyama (1980) showed the following species based on the previous records: *C. emeryi* Forel, *C. nuda* (Mayr), *C. wroughtonii* (Forel). But now the identification of the former 2 species is in question, in particular *emeryi*. In fact I found 5 specimens from Kojima, Kyushu, labeled "*C. venustula* Wheeler" identified by W.L. Brown, Jr. in the collection of the Entomological Laboratory, Kyushu University. It is certain that there are 2 *nuda*-like species which can be distinguished by the body color, the relative length of the scape, and the shape of propodeal spines. Following MSJ (1988) I provisionally list here 2 named species, but the identity of Japanese "*nuda*" with its allied species should wait for further study.

Cardiocondyla nuda (Mayr)

C. wroughtonii (Forel)

The distribution of the genus in Japan is restricted to southern areas, including southern Honshu, Shikoku, Kyushu and the Ryukyus. *C. nuda* and another undetermined species nest under stones in open land, while *C. wroughtonii* in the hollows of twigs. Kinomura & Yamauchi (1987) reported some interesting aspects of the behavior of males in *C. wroughtonii*.

Genus **Tetramorium** Mayr

(Figs. 95-110)

Tetramorium Mayr, 1855, Verh. Zool.-Bot. Ver. Wien 5 : 423. Type species: *Formica caespitum* Linnaeus, 1758, Syst. Nat. ed. 10 : 581, by subsequent designation of Girard, 1879, Traite elementaire d'entomologie 2 : 1016.

Tetrogmus Roger, 1857, Berl. Ent. Z. 1 : 10. Type species: *Tetrogmus caldarius* Roger, 1857, op. cit. : 12, by monotypy.

Xiphomyrmex Forel, 1887, Mitt. Schweiz. Ent. Ges. 7 : 385 (as subgenus of *Tetramorium*). Type species: *Tetramorium* (*Xiphomyrmex*) *kelleri* Forel, 1887, loc. cit., by subsequent designation of Wheeler, 1911, Ann. N.Y. Acad. Sci. 21 : 175.

Triglyphothrix Forel, 1890, Ann. Soc. Ent. Belg. 34 : 106. Type species: *Triglyphothrix walshi* Forel, 1890, op. cit. : 107.

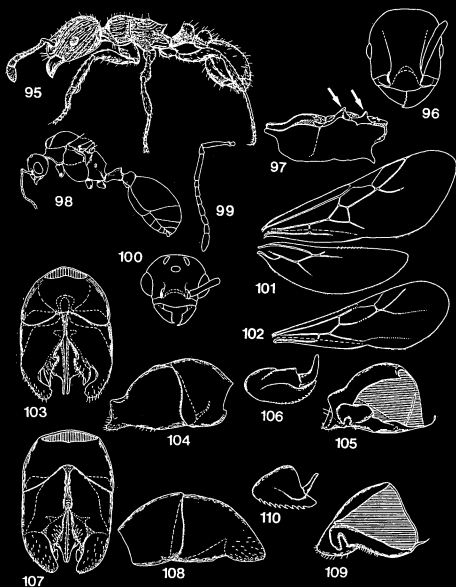
Atopula Emery, 1912, Ann. Soc. Ent. Belg. 56 : 104. Type species: *Atopomyrmex nodifera* Emery, 1901, Dt. Ent. Z. 1901 : 115, by original designation.

Macromischoides Wheeler, 1920, Psyche 27 : 53. Type species: *Macromischa aculaeata* Mayr, 1866, Sber. Akad. Wiss. 53 : 507, by original designation.

Sulcomyrmex Kratochvil, 1941, Ent. Listy 41 : 84 (as subgenus of *Tetramorium*). [No designation of type species.]

Lobomyrmex Kratochvil, 1941, Ent. Listy 41 : 84 (as subgenus of *Tetramorium*). Type species: *Tetramorium* (*Lobomyrmex*) *ferox silhavyi* Kratochvil, 1941, Ent. Listy 41 : 84.

Worker: Head rectangular, longer than broad, with rounded posterior corners; occipital carina present. Mandibles large, subtriangular; masticatory margin with 3 larger apical teeth followed by some minute denticles. Palp formula 4.3 (in Japanese species), rarely 4.2 or 3.2 (Bolton, 1977). Clypeus with median longitudinal carina; anterior margin rounded or shallowly emarginate in the middle; anterolateral portion in front of antennal insertions forming distinct ridge or carina. Frontal carinae usually long and distinct, almost reaching posterior corners of head, with antennal scrobes; anterior portion



Figs. 95-110. *Tetramorium* spp., (95-97, worker; 98-110, male): 95, *T. caespitum*, profile; 96, same, head; 97, same, trunk, ventrolateral view, arrows indicating ventral processes; 98, same, profile; 99, same, right antenna; 100, same, male; 101, same, right wings; 102, *T. lanuginosum*, right fore wing; 103, *T. caespitum*, male genitalia, ventral view; 104, same, lateral view; 105, same, left paramere; 106, same, right aedeagal plate; 107, *T. lanuginosum*, male genitalia, ventral view; 108, same, lateral view; 109, same, left paramere; 110, same, right aedeagal plate.

forming broad frontal lobes which cover antennal insertions. Antennae 11- or 12-segmented; scape not extending beyond posterior corner of head; apical 3 segments forming club. Eyes medium to large in size, situated almost at the midlength of sides of head.

Promesonotal area less raised, without suture dorsally; metanotal groove weakly impressed or absent; propodeal spines varying in shape with species, rarely absent (distinct in Japanese species); posterior portion of propodeum both sides of petiolar insertion forming distinct dentiform projections. Ventral processes present on meso- and metasternum. Legs more or less robust; middle and hind tibiae with small simple spur apically. Petiole pedunculate, with squariform node; subpetiolar process small, dentiform, sometimes reduced or absent. Postpetiolar node rounded, less raised in lateral view. Sting small but distinct, with small triangular flange apically.

Female: General form of head as in worker, with larger eyes and distinct ocelli. Trunk massive; pronotum not overhung by mesonotum; mesonotum thin, flattened dorsally; notauli absent, parapsidal furrows indistinct; mesoscutellum not overhanging metanotum; propodeal spines as in worker but more stout; dentiform projections on both sides of petiolar insertion distinct as in worker. Fore wing with type III venation; m-cu present or absent; radial cell open or closed. Ventral processes of meso- and metasternum, and legs as in worker. Petiole and postpetiole like those of worker, but more massive.

Male: Head subglobose, as broad as or slightly broader than long; occipital carina present. Mandibles narrow, subtriangular; masticatory margin dentate, with distinct and acute apical tooth followed by small 5 teeth in Japanese species. Palp formula 4,3. Clypeus convex in the middle; anterior margin widely rounded; anterolateral portion in front of antennal insertions not so distinct as in worker. Frontal carinae short but distinct, partially covering antennal insertions which are close to posterior margin of clypeus. Antennae 10-segmented; scape extending beyond outer margin of eye in Japanese species; funiculus filiform; second funicular segment (= third antennal segment) distinctly elongate, as long as or longer than two following segments together. Eyes large and prominent. Ocelli well developed.

Pronotum overhung by mesoscutum; mesoscutum convex dorsally, with notauli and parapsidal furrows; mesoscutellum not overhanging metanotum; propodeal spines reduced to obtuse corners; posterior portion of propodeum both sides of petiolar insertion not forming dentiform projections. Wings as in female. Ventral processes absent on mesosternum, but present on metasternum. Legs long and slender; middle and hind tibiae each with a simple small spur. Petiole with shorter peduncle; node compressed anteroposteriorly; subpetiolar process absent. Postpetiole broadly attached to gaster.

Hypopygium broader than long, with small process basally. Genitalia retractile, large; basal ring thick; gonocoxal arms narrow, fused to each other at their basal apices; distal portion of paramere rounded or sometimes modified with dorsal projections; digitus

present, varying in form; cuspis absent; aedeagus broad basally, with serrate ventral margin.

The genus contains about 250 species, most of which are distributed throughout the Old World tropics and subtropics. Bolton revised the genus (1976, 1977, 1979, 1980, 1985).

In Japan, the following 8 species are distributed:

Tetramorium bicarinatum (Nylander)

T. caespitum (Linnaeus)

T. kraepelini Forel

T. lanuginosum Mayr

T. nipponense Wheeler

T. simillimum Mayr

T. tanakai Bolton

T. tonganum Mayr

The record of *T. amium* from the Ryukyus (Yasumatsu, 1940; Onoyama, 1976) was questioned by MSJ (1988). In addition they pointed out that the identity of *kraepelini* and that of *tanakai* are also obscure.

The difference of male genitalia between *T. caespitum* and *lanuginosum* is quite distinct. This may represent a species group level difference.

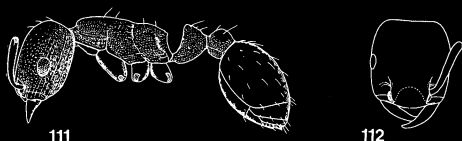
Genus **Strongylognathus** Mayr

(Figs. 111-112)

Strongylognathus Mayr, 1853, Verh. Zool.-Bot. Ver. Wien 3 : 389. Type species: *Eciton testaceum* Schneck, 1852, Jb. Ver. Naturk. Nassau 8 : 117 (= *Myrmus emarginatus* Schneck, 1853), by monotypy.

Myrmus Schneck, 1853, Stettin. Ent. Z. 14 : 188. Type species: *Myrmus emarginatus* Schneck, 1852, Jb. Ver. Naturk. Nassau 8 : 117, by monotypy. [Nom. preoc., nec. Hahn, 1832, Wanzerartigen Insecten 1(3) : 81.]

Worker: Head subrectangular with rounded posterior corners; occipital carina low. Mandibles blade-like, with almost edentate inner margin and acute apex; masticatory margin not differentiate. Palp formula 4,3 (Bolton, 1976). Frontal carinae short, without antennal scrobes. Clypeus narrow, not forming lateral ridge in front of antennal insertion; anterior margin straight or widely rounded. Antennae 12-segmented; scape short, not extending beyond posterior corner of head; apical 3 segments forming club. Eyes medium, situated in the midlength of sides of head.



Figs. 111-112. *Strongylognathus koreanus*, worker: 111, profile; 112, head.

Promesonotal area depressed, without distinct suture; metanotal groove shallow; posterodorsal portion of propodeum with small teeth, or forming simply rounded corner; propodeal spiracle situated almost in the middle of lateral surface of propodeum. Ventral processes on meso- and metasternum indistinct. Legs short; middle and hind tibiae each with short apical spur which is poorly pectinate in Japanese species. Petiole nodiform; node varying with species; subpetiolar process low. Postpetiole subglobose. Sting short.

Female (dealate): General form of head as in worker, with larger eyes and ocelli. Pronotum not overhanging by mesoscutum; anterior portion more or less marginate with obtuse humeri. Mesonotum flattened dorsally; notauli absent, parapsidal furrows present; mesoscutellum not overhanging metanotum. Propodeal teeth more distinct than those of worker. Petiole as in worker, but with more angulate apex of node. Postpetiole subrectangular in dorsal view. The remainder of body as in worker.

Male: Unknown to me.

The genus contains 22 species (Bolton, 1976), distributed in the Palearctic region. The recent revision of the genus including key to species was that of Bolton (1976).

Nakano (1938) stated that Teranishi had prepared a description of Japanese *Strongylognathus* collected from Kosshu by Yano. But because of the sudden death of Teranishi in 1938, the identification of the species have been left undetermined, though Collingwood (1976) also reported the occurrence of the genus in Japan. Recently Terayama (1988) found the specimens preserved in National Institute of Agro-Environmental Sciences and identified as:

Strongylognathus koreanus Pisarski

The species is quite rare. The genus has been known as a social parasite of *Tetramorium*. According to Terayama (1988), the host species of *S. koreanus* is *Tetramorium caespitum*.

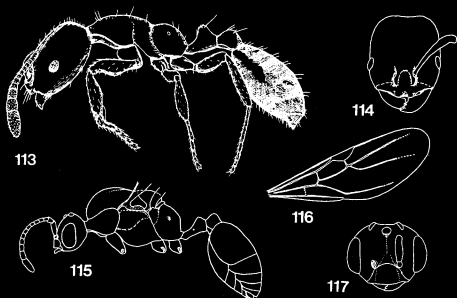
Genus **Monomorium** Mayr

(Figs. 113-117)

- Monomorium* Mayr, 1855, Verh. Zool.-Bot. Ver. Wien 5 : 452. Type species: *Monomorium monomorium* Bolton, 1987, Bull. Birt. Mus. Nat. Hist. (Ent.) 54 : 287, nom. substit., pro. *Monomorium minutum* Mayr, 1855, op. cit. : 453, nom. preocc. (nec. Jerdon, 1851 : 105), by monotypy.
- Trichomyrmex* Mayr, 1865, Reise der Österreichischen Fregatte Novara Zool. : 19. Type species: *Trichomyrmex rogeri* Mayr, 1865 : 19, loc. cit., by monotypy.
- Lampromyrmex* Mayr, 1868, Beitr. Natur. Preuss. 1 : 93. Type species: *Monomorium mayrianum* Wheeler, 1915, Schr. Phys.-Ökon. Ges. Königsb. 55 : 45, nom. substit., pro. *Lampromyrmex gracillimus* Mayr, 1868, op. cit. : 95, (nec. F. Smith, 1861 : 34), by monotypy.
- Holcomyrmex* Mayr, 1878, Verh. Zool.-Bot. Ges. Wien 28 : 671. Type species: *Holcomyrmex scabriceps* Mayr, 1878, op. cit. : 672, by subsequent designation of Bingham, 1903, Fauna Birt. India, Hym. 2 : 280.
- Epoecus* Emery, 1893, Ann. Soc. Ent. Fr. 61 : 276. Type species: *Epoecus pergandei* Emery, 1893, loc. cit., by monotypy.
- Wheeleria* Forel, 1905, Ann. Soc. Ent. Belg. 49 : 171. Type species: *Wheeleria santschii* Forel, 1905, loc. cit., by monotypy. [Nom. preocc., nec. Tutt, 1905 : 37 — Lepidoptera.]
- Wheeleriella* Forel, 1907, Int. Sci. Revue 4 : 145. [Nom. substit., pro. *Wheeleria* Forel, 1905.]
- Epixenus* Emery, 1908, Dt. Ent. Z. 1908 : 556. Type species: *Monomorium advena* Brown & Wilson, 1957, Ent. News 68 : 244, nom. substit., pro. *Epixenus andrei* Emery, 1908, op. cit. : 557, (nec. Saunders, 1890 : 204), by subsequent designation of Wheeler, 1911, Ann. N. Y. Acad. Sci. 21 : 163.
- Mitara* Emery, 1913, Ann. Soc. Ent. Belg. 57 : 261 (as subgenus of *Monomorium*). Type species: *Monomorium laeve* Mayr, 1876, J. Mus. Godeffroy 12 : 101, by original designation.
- Chelaner* Emery, 1914, Nova Caledonia Zool. 1 : 410 (as subgenus of *Monomorium*). Type species: *Monomorium (Chelaner) forcipatum* Emery, 1914, loc. cit., by subsequent designation of Emery, 1922, Gen. Ins. 174 : 168.
- Notomyrmex* Emery, 1915, Bull. Soc. Ent. Fr. 1915 : 190 (as subgenus of *Monomorium*). Type species: *Atta antarctica* F. Smith, 1858, Cat. Hym. Coll. Brit. Mus. 6 : 167, by original designation.
- Xeromyrmex* Emery, 1915, Bull. Soc. Ent. Fr. 1915 : 190 (as subgenus of *Monomorium*). Type species: *Formica salomonis* Linnaeus, 1758, Syst. Natur. ed. 10 : 580, by original designation.
- Parholcomyrmex* Emery, 1915, Bull. Soc. Ent. Fr. 1915 : 190 (as subgenus of *Monomorium*). Type species: *Myrmica gracillima* F. Smith, 1861, J. Proc. Linn. Soc. 5 : 34 (= *Monomorium*

- destructor* (Jerdon), 1851 : 105), by original designation.
- Syllophopsis* Santschi, 1915, Ann. Soc. Ent. Fr. 84 : 259 (as subgenus of *Monomorium*). Type species: *Monomorium modestum* Santschi, 1914, Göteborgs Kungl. Vetensk. Vitter. Samh. Handl. 15 : 17, by monotypy.
- Corynomyrme* Viehmeyer, 1916, Arch. Natur. 81 : 134 (as subgenus of *Monomorium*). Type species: *Monomorium (Corynomyrme) hospitum* Viehmeyer, 1916, loc. cit., by monotypy.
- Isolcomyrme* Santschi, 1917, Ann. Soc. Cient. Argent. 84 : 296 (as subgenus of *Monomorium*). Type species: *Monomorium santschianum* Ettershank, 1966, Aust. J. Zool. 14 : 92, nom. substit. pro. *Holcomyrme santschii* Forel, 1907, Ann. Soc. Ent. Belg. 51 : 203, (nec. Forel, 1905, Ann. Ent. Soc. Belg. 49 : 171), by original designation.
- Paraphacota* Santschi, 1919, Bull. Soc. Ent. Fr. 1919 : 90. Type species: *Paraphacota surcoufi* Santschi, 1919, loc. cit., (= *Monomorium subopacum* (F. Smith), 1858 : 127), by monotypy.
- Equestrimessor* Santschi, 1919, Bull. Soc. Ent. Fr. 1919 : 92 (as subgenus of *Monomorium*). Type species: *Holcomyrme chobauti* Emery, 1897, Bull. Soc. Ent. Fr. 1897 : 418, by subsequent designation of Donisthorpe, 1943, Ann. Mag. Nat. Hist. (11) 10 : 644.
- Xenhyboma* Santschi, 1919, Bol. R. Soc. Esp. Hist. Nat. 19 : 405. Type species: *Xenhyboma mystes* Santschi, 1919, loc. cit. (= *Monomorium medinae* Forel, 1892 : 454), by monotypy.
- Protholcomyrme* Wheeler, 1922, Bull. Amer. Mus. Nat. Hist. 45 : 162 (as subgenus of *Monomorium*). Type species: *Monomorium rothsteini* Forel, 1902, Rev. Suisse. Zool. 10 : 444, by original designation.
- Ireneidris* Donisthorpe, 1943, Ent. Mon. Mag. 79 : 81. Type species: *Ireneidris myops* Donisthorpe, 1943, Ann. Mag. Nat. Hist. (11) 10 : 81 (= *Monomorium talpa* Emery, 1911 : 252), by original designation.
- Schizopelta* McAreavey, 1949, Proc. Linn. Soc. N.S.W. 74 : 14. Type species: *Schizopelta falcata* McAreavey, 1949, op. cit. : 15, by original designation.
- Pharaophanes* Bernard, 1952, Mem. Inst. Fr. Afr. N. 19 : 238. [Nomen nudum.]

Worker: Worker caste monomorphic (in Japanese species) or polymorphic. Head subrectangular, longer than broad in Japanese species, with rounded posterior corners; occipital carina absent. Mandibles narrow, subtriangular; masticatory margin with distinct apical teeth followed by 2 or 3 small denticles. Palp formula 1,2 or 2,2 in Japanese species, otherwise 5,3; 3,3; 2,3; 1,1 in exotic species (Bolton, 1987). Clypeus narrow, with two longitudinal carinae medially which are sometimes indistinct; median portion of anterior margin weakly emarginate with distinct median seta. Frontal carinae short, not extending beyond the level of eyes; anteriorly forming frontal lobes, covering antennal insertions. Antennae 12-segmented in Japanese species, or rarely 10- to 11-segmented; scape not extending beyond posterior corner of head; apical three segment forming club in Japanese species. Eyes medium to small in size, situated slightly anterior to the midlength of sides of head.



Figs. 113-117. *Monomorium* spp. (113-114, worker; 115-117, male): 113, *M. intrudens*, profile; 114, same, head; 115, *M. pharaonis*, profile; 116, same, right fore wing; 117, same, head.

Promesonotal area less raised, without suture; metanotal groove more or less deeply impressed; posterodorsal portion of propodeum rounded or bluntly angled, not forming propodeal spines. Ventral processes on meso- and metasternum absent. Legs short; middle and hind tibiae lacking apical spurs. Petiole pedunculate; crest of node tapering, with rounded corners; subpetiolar process absent. Postpetiole small and globose. Sting small.

Female: General form of head as in worker, with larger eyes and small ocelli. Trunk elongate, with arched node; pronotum overhung by mesoscutum; notauli absent, parapsidal furrows indistinct; mesoscutellum not overhanging metanotum; propodeum rounded dorsally, without spines. Fore wing venation type III to IV; m-cu present or absent; radial cell open. Ventral processes absent as in worker. Remainder of body and appendages like those of worker, but more massive.

Male: Head subglobose, sometimes broadened; occipital carina indistinct; median furrow running from posterior most point of median impression to median ocellus often distinct. Mandibles narrow, armed with 1-4 teeth. Mouth parts not dissected. Clypeus convex in the middle, without median bicarination; anterior margin widely rounded. Frontal carinae and frontal lobes indistinct. Antennal insertions close to posterior margin of clypeus. Antennae 11- to 13-segmented (13 in Japanese species); scape short, cylindrical in Japanese species; funiculus filiform, 1st funicular segment (= 2nd antennal

segment) often globular, apical segment longest. Eyes large and prominent. Ocelli well developed.

Pronotum overhung by mesoscutum; notauli indistinct or absent, parapsidal furrows present; mesoscutellum overhanging metanotum; propodeum with short dorsal surface; posterodorsal corners of propodeal not forming definite projections. Middle and hind tibiae each with small simple spur apically. Wings as in female. Petiole and postpetiole like those of worker, but the latter sometimes compressed. Genitalia not dissected.

The genus contains about 300 species (Ettershank, 1966), most of which are found in the tropics and subtropics in the Old World. Some species are widely spread in the world by human transport.

The ant of this genus are small in size, nesting in rotten wood, hollow twigs, under stones or in soils, frequently inhabiting houses especially in tropical or subtropical areas. Ettershank (1966) gave a redefinition of the genus and presented synonyms. Bolton (1987) revised the Ethiopian species.

In Japan, the following 8 species are recognized:

Monomorium chinense Santschi

M. destructor (Jerdon)

M. floricola (Jerdon)

M. fossulatum Emery

M. intrudens F. Smith

M. latinoda Mayr

M. pharaonis (Linnaeus)

M. triviale Wheeler

The synonymy of *M. intrudens* was discussed by Bolton (1987) and Ogata & Bolton (1989). Ochi (1983) gave a distribution pattern of *M. intrudens*.

Genus **Solenopsis** Westwood

(Figs. 118-127)

Solenopsis Westwood, 1841, Ann. Mag. Nat. Hist. 6 : 86. Type species : *Solenopsis mandibularis* Westwood, 1841, loc. cit. (= *Atta geminata* Fabricius, 1804, Syst. Piez. : 423), by monotypy.

Diplorhoptum Mayr, 1855, Verh. Zool.-Bot. Ges. Wien 5 : 499. Type species : *Formica fugax* Latreille, 1798, Essai Fourmis de la France : 46, by monotypy.

Synsolenopsis Forel, 1918, Bull. Soc. Vaud. Sci. Nat. 52 : 155 (as subgenus of *Solenopsis*).

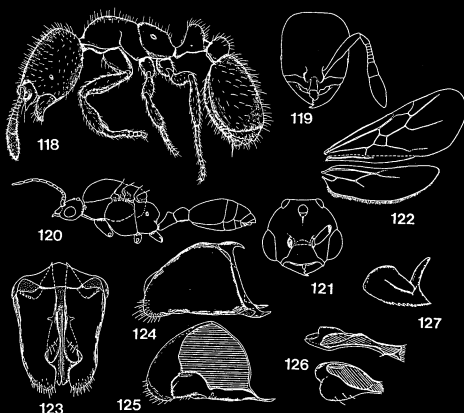
Type species : *Solenopsis bruchiella* Emery, 1921, Gen. Ins. 174 : 199, nom. substit., pro.

- Solenopsis bruchi* Forel, 1918, op. cit.: 156, (nec. Forel, 1912), by monotypy.
- Diagyne* Santschi, 1923, Rev. Suisse. Zool. 30 : 267 (as subgenus of *Solenopsis*). Type species : *Solenopsis succinea* Emery, 1890, Boll. Soc. Ent. Ital. 22 : 52, by monotypy.
- Labauchena* Santschi, 1930, Revta. Soc. Ent. Argent. 13 : 81. Type species : *Labauchena daguerrei* Santschi, 1930, loc. cit., by monotypy.
- Euophthalma* Creighton, 1930, Proc. Am. Acad. Arts Sci. 66 : 43 (as subgenus of *Solenopsis*). Type species : *Myrmica globularia* F. Smith, 1858, Cat. Hym. Birt. Mus. 6 : 131, by original designation.
- Oedaleocerus* Creighton, 1930, Proc. Am. Acad. Arts Sci. 66 : 43 (as subgenus of *Solenopsis*). Type species : *Solenopsis angulata* Emery, 1894, in von Ihering, Berl. Ent. Z. 39 : 393, by original designation.
- Bisolenopsis* Kusnezov, 1953, Acta Zool. Lilloiana 13 : 1. Type species : *Bisolenopsis sea* Kusnezov, 1953, loc. cit., by monotypy.
- Paranamyrmica* Kusnezov, 1954, Mem. Mus. Entre Rios 30 : 9. Type species : *Paranamyrmica solenopsidis* Kusnezov, 1954, op. cit. : 12, by monotypy.
- Lilidris* Kusnezov, 1957, Zool. Anz. 158 : 268. Type species : *Lilidris metatarsalis* Kusnezov, 1957, op. cit. : 274, by monotypy.
- Granisolenopsis* Kusnezov, 1957, Zool. Anz. 158 : 270 (as subgenus of *Solenopsis*). Type species : *Solenopsis (Granisolenopsis) granivora* Kusnezov, 1957, op. cit. : 278, by monotypy.

Worker: Worker caste polymorphic or monomorphic. Head subrectangular, with rounded posterior corners; occipital carina absent. Mandibles narrow, subrectangular; masticatory margin with acute apical tooth followed by a few small denticles. Palp formula 1,2. Clypeus with paired longitudinal carinae; anterior margin produced forward, with median paired teeth and blunt lateral projections; Frontal carinae short, not extending beyond the level of eyes; anteriorly forming frontal lobes which cover antennal insertions. Antennae 10-segmented; scape not exceeding posterior corner of head; apical 2 segments forming club. Eyes small, situated at anterior 1/3 of sides of head.

Promesonotal area not raised, lacking suture; metanotal groove impressed; propodeum rounded posterodorsally, without spines; propodeal spiracles situated in the middle of lateral surface. Ventral processes absent on meso- and metasternum. Legs short; middle and hind tibiae each with a small apical spur. Petiole nodiform with anterior peduncle; node with rounded anterior and posterior corners in profile; subpetiolar process present as small thin lamella. Postpetiole small, subglobose. Sting more or less developed.

Female: General form of head as in worker, with larger eyes and distinct ocelli. Trunk massive; pronotum overhung by mesoscutum; mesonotum swollen, arched dorsally; notauli absent, parapsidal furrows present; mesoscutellum overhanging metanotum; propodeum with short and arched dorsal surface, and with vertical posterior face; propodeal spines reduced. Fore wing with type III venation; hind wing narrow. Ventral



Figs. 118-127. *Solenopsis japonica*. (118-119, worker; 120-127, male): 118, profile; 119, head; 120, profile; 121, head; 122, right wings; 123, male genitalia, ventral view; 124, same, lateral view; 125, left paramere; 126, right volsella, dorsal view (upper) and lateral view (lower); 127, right aedeagal plate.

processes absent. The remainder of body and appendages like those of worker.

Male (*fugax*-group): Head globose, almost as long as broad excluding eyes; occipital carina low. Mandibles small and narrow; masticatory margin with acute apical tooth followed by a few smaller denticles. Palp formula 1,2. Clypeus well convex in the middle, without longitudinal bicarination; anterior margin widely rounded. Frontal carinae and frontal lobes indistinct. Antennal insertions exposed, situated close to posterior margin of clypeus. Antennae 12-segmented; scape short; funiculus filiform, second antennal segment large and globose. Eyes large and prominent. Ocelli well developed.

Pronotum overhung by mesoscutum; mesonotum well convex dorsally; notauli absent, parapsidal furrows present; mesoscutellum convex, overhanging metanotum; propodeum with short and arched dorsal surface and rounded posterodorsal corner. Wings as in female. Ventral processes absent on meso- and metasternum. Legs long and slender; middle and hind tibiae each with a simple spur. Petiolar node lower than that of worker; subpetiolar process absent. Postpetiole globose, widely attached to gaster.

Hypopygium broader than long, with rounded apex; basal margin with a distinct projection in the middle. Genitalia partly retractile; basal ring distinctly thin; paramere shortened with small gonocoxal arm and rounded apex; volsella apically forming rounded lamella which bears scales ventrally; digitus and cuspis reduced; aedeagal plate subtriangular with rounded apex and serrate ventral margin.

The genus is distributed world wide. Ettershank (1966) listed over 270 names, but it is thought to include many synonyms.

Baroni Urbani (1968) raised the subgenus *Diplorhoptrum* to generic rank, but again Bolton (1987) synonymized with *Solenopsis*. The relationship of "*Diplorhoptrum*" or *fugax*-group of *Solenopsis* to other members of *Solenopsis* is not clear. Besides the value of male genital character, there is no evidence of synapomorphies of *Solenopsis* sensu Baroni Urbani. Although the *fugax*-group of *Solenopsis* has a peculiar genital structure, and hence it supposed to be a monophyletic group, the monophyly of the remainder has not been justified so far. Thus the Bolton's view is accepted here.

In Japan two species are known:

Solenopsis japonica Wheeler **n. stat.** (provisional)

S. geminata (Fabricius)

The first record of the genus in Japan was that of André (1903) who reported the Japanese species as *fugax* Latreille. Later Wheeler (1928) recognized the difference between Japanese material and European *fugax*, and described it as var. *japonica*. I provisionally treat *japonica* as species, but for the exact status further study of *fugax*-group is necessary. Another species, *S. geminata*, was reported from Okinawa Island by Kubota (1983) who suggested a temporary introduction from a foreign area.

Genus **Oligomyrmex** Mayr

(Figs. 128-140)

Oligomyrmex Mayr, 1867, Tijdschr. Ent. 10 : 110. Type species : *Oligomyrmex concinnus* Mayr, op. cit. : 111, by monotypy.

Aeromyrma Forel, 1891, Ann. Soc. Ent. Belg. 35 : 307. Type species : *Aeromyrma nosindambo* Forel, 1891, op. cit. : 199, by monotypy.

Aneuleus Emery, 1900, Term. Füz. 23 : 327 (as subgenus of *Pheidologeton*). Type species : *Solenopsis similis* Mayr, 1862, Verh. Zool.-Bot. Ges. Wien 12 : 751, by subsequent designation of Wheeler, 1911, Ann. N.Y. Acad. Sci. 21 : 158.

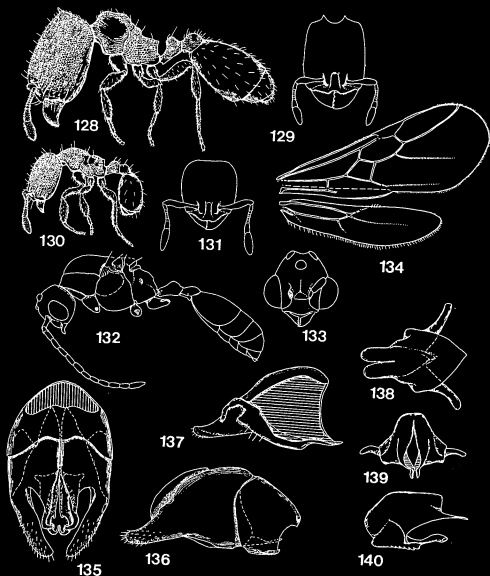
Erebomyrma Wheeler, 1903, Biol. Bull. Mar. Biol. Lab. Woods Hole 4 : 138. Type species : *Erebomyrma longi* Wheeler, 1903, op. cit. : 140, by monotypy.

- Lecanomyrma* Forel, 1913, Zool. Jb. Syst. 36 : 56 (as subgenus of *Pheidologeton*). Type species: *Pheidologeton* (*Lecanomyrma*) *butteli* Forel, loc. cit., by monotypy.
- Octella* Forel, 1915, Ark. Zool. 9 : 69 (as subgenus of *Oligomyrmex*). Type species: *Oligomyrmex* (*Octella*) *pachycerus* Forel, 1915, loc. cit., by monotypy.
- Spelaomyrmex* Wheeler, 1922, Am. Mus. Novit. (45) : 9. Type species: *Spelaomyrmex urichi* Wheeler, 1922, loc. cit., by original designation.
- Hendecatella* Wheeler, 1927, Boll. Lab. Zool. Gen. Agr. Portici 20 : 93 (as subgenus of *Oligomyrmex*). Type species: *Oligomyrmex* (*Hendecatella*) *capreolus* Wheeler, 1927, loc. cit., by monotypy.
- Solenops* Karawajew, 1930, Zool. Anz. 92 : 207 (as subgenus of *Solenopsis*). Type species: *Solenopsis* (*Solenops*) *weyeri* Karawajew, 1930, loc. cit., by monotypy (nom. preocc., nec. L. Dufour, 1820 — Arachnida).
- Sporocleptes* Arnold, 1948, Occ. Pap. Natn. Mus. Sth Rhod. 2 : 219. Type species: *Sporocleptes nicotiana* Arnold, 1948, loc. cit., by monotypy.
- Crateropsis* Patrizi, 1948, Boll. Ist. Ent. Univ. Bologna 17 : 174 (as subgenus of *Solenopsis*). Type species: *Solenopsis* (*Crateropsis*) *elementatae* Patrizi, 1948, loc. cit., by monotypy.
- Nimbamyrmex* Bernard, 1953, Mem. Ist. Franc. Afr. Noire 19 : 240. Type species: *Nimbamyrmex villiersi* Bernard, 1952, op. cit. : 241, by monotypy.

Worker: Worker caste dimorphic, consisting of major (soldier) and minor (worker, s.str), usually not connected by intermediates.

Major worker — Head massive, elongate; posterior margin emarginate in the middle, and with paired occipital lobes; posterodorsal surface sometimes bearing a pair of small projections; occipital carina low, sometimes indistinct. Mandibles subtriangular, large and stout; masticatory margin with 4–6 teeth. Palp formula 2,2. Clypeus narrow, often with paired longitudinal carinae; anterior margin more or less marginate. Labrum longer than broad, with small but distinct dorsal projection anteromedially. Frontal carinae short or indistinct, anteriorly forming frontal lobes, covering antennal insertions. Antennae 9- to 11-segmented (9-segmented in most of the Japanese species); scape short, at most reaching the midlength of head; first funicular segment (= second antennal segment) as long as or longer than the following three segments together; apical 2 segments forming distinct club. Eyes small to minute, situated anterior to midlength of sides of head.

Pro- and mesonotum fused together, forming convexity; promesonotal suture absent dorsally; metanotal groove more or less deeply impressed; posterior portion of propodeum lamellate, and often forming small dentiform projections dorsally. Ventral processes absent on meso- and metasternum. Legs short and robust; middle and hind tibiae without apical spurs. Petiole nodiform with anterior peduncle; subpetiolar process present on anteroventral portion as small tooth. Postpetiole small with rounded node;



Figs. 128-140. *Oligomyrmex sauteri*. (128-129, major worker; 130-131, minor worker; 132-140, male): 128, profile; 129, head; 130, profile; 131, head; 132, profile; 133, head; 134, right wings; 135, male genitalia, ventral view; 136, same, lateral view; 137, left paramere; 138, aedeagal plates, dorsal view; 139, same, caudal view; 140, same, lateral view.

sternum so small that postpetiole connects at an angle with gaster. Sting small.

Minor worker — Head subrectangular, with rounded posterior corners. Mandibles as in major worker, but smaller in size. Palp formula 2,2 in Japanese species examined. The rest of head and its appendages like those of major worker.

Trunk as in worker, with less raised promesonotal area. Remainder of body and legs as in major worker.

Female: Head subrectangular, usually longer than broad, with larger eyes and distinct ocelli; paired projections on posterodorsal surface of head absent; occipital carina present. Mandibles, palp formula, clypeus, frontal carinae and antennae like those of worker.

Trunk elongate; pronotum overhung by mesoscutum; mesonotum long and arched dorsally; notauli absent, parapsidal furrows present; mesoscutellum flat dorsally, not overhanging metanotum; propodeum shortened, with paired obtuse lobes posterodorsally. Fore wing with type III venation; m-cu present; radial cell closed in Japanese *sauteri*; hind wing narrow. Ventral processes absent on meso- and metasternum. Legs, petiole and postpetiole like those of worker, but more massive. Gaster large and elongate.

Male: Head subglobose, usually longer than broad excluding eyes; posterior margin slightly concave; occipital carina low. Mandibles subtriangular, small and narrow; masticatory margin with acute apical tooth and a few small basal teeth. Palp formula 2,2. Clypeus convex in the middle without distinct longitudinal carinae; anterior margin widely rounded. Frontal carinae absent. Antennal insertions exposed, situated close to posterior margin of clypeus. Antennae 13-segmented; scape short, usually not reaching outer margin of eyes; funiculus filiform, not forming segmental club. Eyes large and prominent. Ocelli distinct.

Trunk narrow; pronotum overhung by mesoscutum; mesonotum elongate, arched dorsally; notauli absent, parapsidal furrows weakly impressed; mesoscutellum not overhanging metanotum; propodeum with short and rounded dorsal surface; posterodorsal portion of propodeum with obtuse angled corners, but not forming dentiform projections. Wings as in female. Ventral processes absent on meso- and metasternum. Legs long and slender; middle and hind tibiae without apical spurs. Petiolar node low and rounded; subpetiolar processes low or indistinct. Postpetiole depressed dorsoventrally, broadly connected with gaster. First gastral segment large.

Genitalia retractile; basal ring thick; paramere with long and narrow gonocoxal arm, tapering toward apex; digitus slender, angulately curved ventrally; cuspis absent; aedeagal plate with emarginate apex and laterally projecting apodeme, dorsally forming well sclerotized wing.

The genus includes about 100 species, mostly found in the Old World tropics and subtropics, but a few species occur in the New World. Ettershank (1966) gave a generic synonymy. The African species were revised by Weber (1950b).

In Japan the genus has been represented by a single described species:

Oligomyrmex sauteri Forel

This species was originally described from Taiwan, and is found in the southwestern

part of Japan. The species nests in the soil of forest floors. As shown in Figs. 138-140, the shape of aedeagus is unique within the Myrmicinae, but it is difficult to judge whether it represents a generic character or species distinction.

In addition to this species, there are at least 2 species in Japan (Onoyama, 1976) which remain undetermined.

Genus *Vollenhovia* Mayr

(Figs. 141-151)

Vollenhovia Mayr, 1865, Reise der sterreichischen Fregatte Novara um die Erde, Zool. Pt. 2, vol. 1 : 21. Type species: *Vollenhovia punctatostrata* Mayr, loc. cit., by monotypy.

Heteromyrmex Wheeler, 1920, Psyche, 27 : 53. Type species: *Vollenhovia rufiventris* Forel, 1901, Ann. Soc. Ent. Belg. 45 : 374, by monotypy.

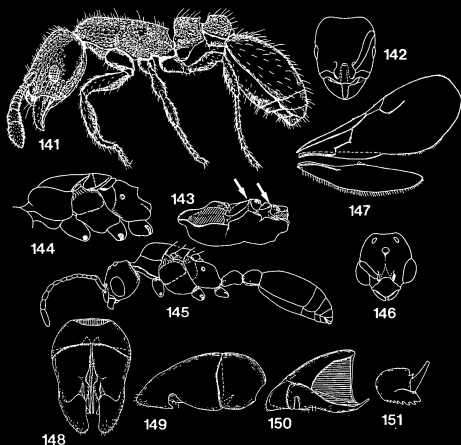
Dyomorium Donisthorpe, 1947, Ann. Mag. Nat. Hist. (11) 14 : 191. Type species: *Dyomorium ireneum* Donisthorpe, loc. cit., by monotypy.

Dorothea Donisthorpe, 1948, Ent. Rec. J. Var. 60 : 65. Type species: *Dorothea novobritainae* Donisthorpe, loc. cit., by monotypy.

Worker: Head subrectangular, longer than broad, with rounded posterior corners; posterior margin slightly emarginate in the middle; occipital carina low. Mandibles subtriangular; masticatory margin with 4-7 teeth (Ettershank, 1966). Palp formula 2,2. Clypeus more or less longitudinally bicarinate; anterior margin roundly produced, usually with shallow emargination. Frontal carinae short, anteriorly forming frontal lobes which cover antennal insertions. Antennae 12-segmented; scape short, usually not reaching posterior corners of head; apical three segments forming club. Eyes medium, situated almost at the midlength of sides of head.

Trunk depressed dorsally; promesonotal suture absent dorsally; metanotal groove weakly impressed; posterodorsal portion of propodeum with rounded corners or small teeth. Ventral processes distinct on meso- and metasternum. Legs short and robust; middle and hind tibiae lacking distinct apical spurs. Petiole nodiform; anterior peduncle short and obscure; subpetiolar process usually forming large blade-like lamella, but sometimes completely absent. Postpetiole globose. Sting reduced.

Female: General form of head as in worker, with larger eyes and small but distinct ocelli. Pronotum not overhung by mesoscutum, with rather angulate humeri; mesonotum thin in lateral view, flattened dorsally; notauli absent, parapsidal furrows present; mesoscutellum depressed, not overhanging metanotum; propodeum with rounded dorsal surface and paired dentiform projections posterodorsally. Ventral processes distinct as in



Figs. 141-151. *Vollenhovia emeryi*. (141-143, worker; 144, female; 145-151, male): 141, profile; 142, head; 143, trunk, ventrolateral view, arrows indicating ventral processes; 144, trunk; 145, profile; 146, head; 147, right fore wings; 148, male genitalia, ventral view; 149, same, lateral view; 150, left paramere; 151, right paramere.

worker. Fore wing venation type IV; most veins below stigma indistinct or absent; hind wing almost lacking veins with long marginal hairs. Remainder of body and appendages like those of worker.

Male: Head subrectangular, longer than broad excluding eyes; posterior margin slightly concave in the middle; ventrolateral portion forming angular corners; occipital carina more or less distinct. Mandibles reduced, small and narrow with rounded apices. Palp formula 2.2. Clypeus well convex in the middle; median portion of anterior margin produced forward, forming triangular shape. Frontal carinae indistinct. Antennal insertions exposed, close to posterior margin of clypeus. Antennae 13-segmented; scape short, usually not extending beyond outer margin of eye; funiculus filiform, incrassate, but not forming segmental club. Eyes large and prominent. Ocelli small, but distinct.

Pronotum overhung by mesoscutum; mesonotum elongate with flattened dorsal surface; notauli absent, parapsidal furrows present; mesoscutellum depressed, not overhanging metanotum; propodeum with arched dorsal surface and rounded posterodorsal corners. Fore and hind wings as in female. Ventral processes absent on meso- and metasternum. Legs slender; middle and hind tibial spurs indistinct. Petiolar node as in worker, but lower and more rounded; subpetiolar process less distinct, forming small angulate projection. Postpetiole as in worker, but more rounded.

Hypopygium pentagonal, with distinct basal projection medially. Genitalia retractile; basal ring thick; gonocoxal arm small; paramere distinctly concave at apical 1/3 of its ventral surface, with rounded apex; digitus angulately curved ventrally; cuspis reduced; aedeagal plate shortened with rounded apex and serrate ventral margin.

The genus includes about 60 described species, distributing throughout the Oriental region, New Guinea, and Oceanic Islands. Ettershank (1966) gave a generic synonymy.

In Japan the genus has been represented by 2 species:

Vollenhovia chosenuka Wheeler

V. emeryi Wheeler

The taxonomic status of the former species was questioned by MSJ (1988). The latter nests in rotten wood or under the bark of logs. Yamauchi recently found a parasitic form of the genus (Yamauchi, pers. com.).

Genus **Trigonogaster** Forel

(Figs. 152-153)

Trigonogaster Forel, 1890, Ann. Soc. Ent. Belg. 34 : 109. Type species: *Trigonogaster recurvispinosa* Forel, 1890, op. cit. : 110, by monotypy.



Figs. 152-153. *Trigonogaster* sp., worker : 152, profile; 153, head.

Worker: Head subrectangular, longer than broad, with rounded posterior corners; occipital carina low. Mandibles subtriangular; masticatory margin with four (or five according to Ettershank, 1966) teeth; basal tooth branched, situated apart from the rest of teeth. Palp formula 5.3. Median portion of clypeus raised, with two longitudinal carinae; anterior margin widely rounded and vertically raised, with shallow emargination medially. Frontal carinae short, anteriorly forming frontal lobes which cover antennal insertions. Antennae 11-segmented; scape reaching posterior corner of head; apical three segments forming club. Eyes medium, situated anterior to midlength of sides of head.

Promesonotum raised, without dividing suture dorsally; metanotal groove impressed; propodeal spines distinct, vertically raised and curved forward; propodeal spiracle situated at the middle of propodeum. Ventral processes absent on meso- and metasternum. Legs short; middle and hind tibiae each with a small but distinct apical spur. Petiole nodiform, with anterior peduncle and low node; subpetiolar process present as thin lamella; posteroventral portion bearing paired low carinae running longitudinally. Postpetiole depressed; node low, and trapezoid in dorsal view; posterior portion broadly attached to gaster. Gaster flat dorsally forming triangular shape in lateral view. Sting reduced.

Female and male: Unknown to me.

Although the genus has been represented by a single species, *Trigonogaster recurvispinosa* described from east India, Kugler (1986) mentioned 3 additional unidentified species in his analysis of sting apparatus of the tribe Pheidologetini. The distribution is rather wide in the Oriental region ranging from eastern India through Southeast Asia to China and the Ryukyus of Japan.

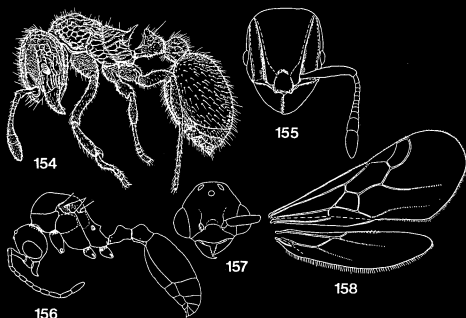
In Japan, the genus occurs in Iriomote Is. and Ishigaki Is. of the Ryukyus. Workers can be collected by sweeping shrubs and colonies are found under stones in rather open land.

Compared with the Figure 139 of Ettershank (1966), the species from the Ryukyus is different from *T. recurvispinosa* in having a more acute apex of subpetiolar process as pointed out by Onoyama (1976). Since the isolated description of a new species is not the aim of this paper and I have not made a detailed comparison of whole material of the genus, the taxonomic treatment of the Japanese species should be wait for further study.

Genus **Lordomyrma** Emery

(Figs. 154-158)

Lordomyrma Emery, 1897, Term. Füz. 20: 591. Type species: *Lordomyrma furcifera* Emery, 1897, loc. cit., by subsequent designation of Wheeler, 1911, Ann. N.Y. Acad. Sci. 21: 166.



Figs. 154-158. *Lordomyrma azumai*, (154-155, worker; 156-158, male): 154, profile; 155, head; 156, profile; 157, head; 158, right wings.

Worker: Head subrectangular, longer than broad, with rounded posterior corners; occipital carina low. Mandibles subtriangular: masticatory margin with 8 teeth. Palp formula 4, 3 in Japanese *azumai*. Clypeus with paired longitudinal carinae; median portion raised; anterior margin projecting forward over basal margin of mandibles, with median emargination. Frontal carinae long and distinct, almost reaching to posterior corners of head in Japanese *azumai*, with deep antennal scrobes; anteriorly forming broad frontal lobes which cover antennal insertions. Antennae 12-segmented; scape reaching posterior corner of head; funiculus incrassate; apical three segments forming club. Eyes moderate, convex, situated anterior to the midlength of sides and just ventrad of antennal scrobes.

Promesonotum raised, forming a single convexity; promesonotal suture indistinct or absent; mesoprecoxal ridge dividing lateral and ventral portions of mesepisternum well developed, partially covering fore coxa; metanotal groove deeply impressed; propodeal spine acute; posterior portion of propodeum both sides of petiolar insertion forming lamellae with dentiform projections; propodeal spiracle situated well forward and apart from posterior margin. Ventral processes absent on meso- and metasternum. Legs stout; tibial spurs on middle and hind legs indistinct. Petiole nodiform with anterior peduncle; apex of node sometimes forming a distinct and acute spine in exotic species, but simple in Japanese species; subpetiolar process small, forming thin lamelliform projection.

Postpetiole globose. First gastral segment distinctly large and globose. Sting well developed.

Female: General form of head as in worker, with larger eyes and small ocelli. Pronotum with more or less distinct humeral angle, not overhung by mesoscutum; notauli absent, parapsidal furrows indistinct; mesoscutellum overhanging metanotum; propodeal spines as in worker, but larger and stouter. Fore wing with type III venation. Legs, petiole, postpetiole and gaster like those of worker.

Male: Head subglobose, depressed dorsoventrally; posterior margin short, widely rounded or straight; occipital carina low. Mandibles developed, subtriangular; masticatory margin with 4 teeth in Japanese species. Palp formula 3,2 in Japanese species. Clypeus convex in the middle, without median paired carinae; anterior margin widely rounded. Frontal carinae short, not forming frontal lobes. Antennal insertions exposed, close to posterior margin of clypeus. Antennae 13-segmented; scape thick; funiculus filiform. Eyes large and prominent, with numerous hairs in Japanese *azumai*. Ocelli distinct.

Pronotum overhung by mesoscutum; mesonotum convex dorsally; notauli and parapsidal furrows impressed on mesoscutum; mesoscutellum overhanging metanotum; propodeum elongate, with arched dorsal surface which declines posteriorly and does not differentiate posterior face; propodeal spines small, dentiform. Wings as in female. Middle and hind tibial spurs absent. Petiole and postpetiole like those of worker, with lower and more rounded nodes. First gastral segment large. Genitalia not dissected.

The genus includes about 10 described species, most of which are found in New Guinea and northwestern Australia. Wheeler (1919) revised the genus, and Yasumatsu (1950) showed the distribution range of the genus and drew up a species list.

In Japan the genus has been represented by single species:

Lordomyrma azumai (Santschi)

This species is found in southwestern Japan, but is rather rare. Different from other species of the genus, *L. azumai* is primarily a temperate species. The southern most record so far in Japan is that from Yakushima Island (Terayama & Yamane, 1984). The species can be seen in soils of broadleaved forest floors.

Genus **Myrmecina** Curtis

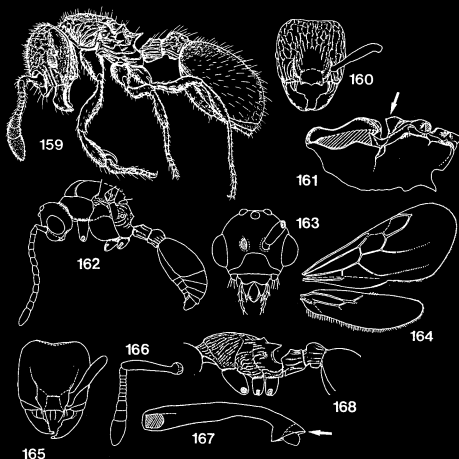
(Figs. 159-168)

Myrmecina Curtis, 1892, Brit. Ent. 6 : 226. Type species: *Myrmecina latreillii* Curtis, 1892, loc. cit. (= *Formica graminicola* Latreille), by original designation.

Archaeomyrmex Mann, 1921, Bull. Mus. Comp. Zool. Harv. 64 : 448. Type species :

Archaeomyrmex cacabau Mann, 1921, loc. cit., by original designation.

Worker: Head subrectangular, longer than broad, with rounded posterior corners; occipital carina low, extending to ventral surface forming parallel longitudinal rugae. Mandibles stout, subtriangular with robust basal arm; basal margin apart from anterior margin of clypeus when closed; masticatory margin with distinct 2 apical teeth followed by small and indistinct 7 or 8 denticles; masticatory axis forming almost right angle with long axis of head. Labrum with small but distinct dorsal projections. Palp formula 4.3. Median portion of clypeus raised; anterior margin projecting forward. Frontal carinae short, with broad frontal lobes which cover antennal insertions. Antennae 12-segmented; scape short, usually not extending beyond posterior corner of head; apical 3 segments forming club. Eyes small to medium, well convex, situated anterior to the midlength of



Figs. 159-168. *Myrmecina* spp. (159-161, 165-168, worker; 162-164, male): 159, *M. graminicola nipponica*, profile; 160, same, head; 161, same, trunk, ventrolateral view; 162, same, profile; 163, same, head; 164, same, right wings; 165, *M. flava*, head (surface sculpture omitted); 166, same, right antennal scape, arrow indicating condyle cover; 167, same, trunk, petiole and postpetiole.

sides of head.

Trunk short, stout, with slightly convex node in profile; pronotum with distinct humeral angle; posterolateral portion of pronotum projecting and partly covering fore coxa; promesonotal area depressed without distinct suture; mesoprecoxal ridge well developed, projecting over base of fore coxa; metanotal groove weakly impressed or absent; dorsal portion of propodeum just posterior to metanotal groove bearing small paired processes; propodeal spine more or less distinct, with acute apex; posterior portion of propodeum both sides of petiolar insertion forming lamelliform ridges. Ventral processes absent on meso- and metanotum. Legs robust; middle and hind tibial spurs absent. Petiole cylindrical, truncate anteriorly, without distinct anterior peduncle; subpetiolar process dentiform or absent. Postpetiole with rounded node, broadly attached to gaster. Sting small.

Female: General form of head as in worker, with larger eyes and small ocelli. Trunk short as in worker; pronotum marginate anteriorly, not overhung by mesoscutum; mesonotum more or less flattened dorsally; notauli absent, parapsidal furrows present; mesoscutellum overhanging metanotum; propodeum declining posteriorly; propodeal spines stout. Fore wing with type III venation; m-cu absent; radial cell closed. Remainder of body and appendages like those of worker.

Male: Head subglobose, compressed dorsoventrally; occipital carina low. Mandibles reduced to rudimentary small lobes with a few setae. Palp formula 3.2. Clypeus convex in the middle, with straight anterior margin. Frontal carinae less developed. Antennal insertions exposed, situated almost in the middle of head length apart from posterior margin of clypeus. Antennae 13-segmented; scape shorter than apical segment of antenna; funiculus rather thick, filiform. Eyes large and prominent. Ocelli well developed.

Pronotum overhung by mesoscutum; mesonotum thick, convex dorsally; notauli distinct, parapsidal furrows present but often weakly impressed on mesoscutum; mesoscutellum overhanging metanotum; mesoprecoxal ridge absent; propodeum with short dorsal surface and dentiform projections posterodorsally. Fore wing venation as in female. Middle and hind tibiae each with a single apical spur. Petiole and postpetiole like those of worker. Genitalia not dissected.

The genus includes about 20 described species, distributed in the temperate Palearctic, Oriental and Nearctic regions. Most of the species are found in the Indo-Malayan region, but remain unstudied.

In Japan, the genus has been represented by 2 described species:

Myrmecina graminicola nipponica Wheeler

M. flava Terayama

The status of *nipponica* is not clear to me. It should be studied by more extensive material. Another species *M. flava* is rare. The species is charactersitic in having a basal

cover on the articulation condyle in the antennal scape (Figs. 166-167), though Terayama (1985a) did not refer to this peculiar structure.

All the species are found in the soils of forest floors.

Genus **Pristomyrmex** Mayr

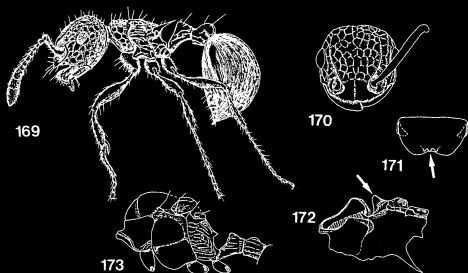
(Figs. 169-173)

Pristomyrmex Mayr, 1866, Verh. Zool.-Bot. Ges. Wien 16 : 903. Type species: *Pristomyrmex pungens* Mayr, op. cit. : 904, by monotypy.

Odontomyrmex André, 1905, Rev. Ent. 24 : 207 (as subgenus of *Pristomyrmex*). Type species: *Pristomyrmex* (*Odontomyrmex*) *quadridentata* André, 1905, loc. cit., by monotypy.

Hylidris Weber, 1941, Ann. Ent. Soc. Amer. 34 : 190. Type species: *Hylidris myersi* Weber, 1941, loc. cit., by original designation.

Dodous Donisthorpe, 1946, Proc. R. Ent. Soc. Lond. ser. B 15 : 145. Type species: *Dodous trispinosus* Donisthorpe, 1946, loc. cit., by original designation.



Figs. 169-173. *Pristomyrmex pungens*, (169-172, worker; 173, male): 169, profile; 170, head; 171, labrum, arrow indicating dorsal teeth; 172, trunk, ventrolateral view, arrow indicating precoxal ridge; 173, trunk.

Worker: Head rounded, nearly as long as broad; occipital carina low. Mandibles narrow, subtriangular; masticatory margin broadened, with 2 acute apical teeth and small basal tooth which are separated by diastema; masticatory axis forming vertical angle with long axis of head. Palp formula 5,3 (in Japanese *pungens*); 4,3; 2,3 or 1,3 (Bolton, 1981). Clypeus with median longitudinal carina which is sometimes indistinct or absent; anterior portion raised and projecting forward to form broadly rounded apron; anterior margin variously armed with denticles; anterolateral portion in front of antennal insertions forming distinct carina or ridge. Frontal carina variously developed, with shallow antennal scrobe. Antennal insertions exposed, surrounded by deep concavity. Antenna 11-segmented; scape long, exceeding beyond posterior border of head; apical 3 segments forming club. Eyes medium, well convex, situated at the midlength of sides of head.

Trunk shortened; pronotum marginate anteriorly, often with paired projections on humeral area; promesonotal area depressed, without suture; mesoprecoxal ridge well developed, projecting over basal portion of fore coxa; metanotal groove indistinct; propodeal spine distinct; posterior portion of propodeum both sides of petiolar insertions forming dentiform lamellae. Ventral processes absent on meso- and metasternum. Legs robust; middle and hind tibiae each with apical spur. Petiole nodiform with narrow anterior peduncle; subpetiolar process present or absent. Postpetiole compressed, with rounded node. Sting developed.

Female (ergatogyne): Normal winged form unknown to me. In *P. pungens*, only the ergatogyne type has been known.

General form of head like that of worker, but broader, and with larger eyes and small ocelli. Trunk more massive than that of worker; each thoracic component incompletely differentiated; anterior portion of pronotum more angulate than in worker; mesonotum raised with indistinct scuto-scutellar suture; metanotum almost fused with mesonotum; area between metanotum and propodeum forming groove; propodeum as in worker, with more vertical posterior face. Area between mesonotum and mesopleuron and that between metanotum and metasternum completely closed. Fore and hind wings completely lacking, but rudimentary wing buds visible through thoracic plate as dark spot. Remainder of body and appendages like those of worker.

Male: Head subglobose, depressed dorsoventrally; occipital carina low. Mandibles reduced, forming rounded lobes with a few setae. Palp formula 4,3 in Japanese *pungens*. Clypeus convex in the middle without median carina; anterior margin almost straight. Frontal carinae less developed. Antennal insertions exposed, situated apart from posterior margin of clypeus. Antennae 12-segmented; scape shorter than apical segment of antenna; funiculus rather thick, filiform. Eyes large and prominent. Ocelli well developed.

Pronotum overhung by mesoscutum, with rounded humeri; mesonotum thick, convex dorsally; notauli deeply impressed, parapsidal furrows weakly impressed; mesoscutellum overhanging metanotum; mesoprecoxal ridge absent; propodeum shortened with post-

eriorly declining dorsal surface; propodeal spine dentiform. Fore wing with type III venation. Middle and hind tibiae each with long apical spur. Petiole and postpetiole like those of worker. Genitalia not dissected.

The genus includes about 40 described species, distributed in the Old World tropics and subtropics and in eastern Australia. Regional revisions include those of Bolton (1981) for the Ethiopian species, Brown (1971b) for the Malagasy species, and Taylor (1965, 1968a) for the Australian species. The species of the Oriental region has not been revised.

Two species occur in Japan:

Pristomyrmex brevispinosus sulcatus Emery

P. pungens Mayr

MSJ (1988) applied *Pristomyrmex brevispinosus* subsp. *sulcatus* var. *formosae* for the species from Iriomote Is. This name was originally proposed by Forel in 1912 (Ent. Mitt. Berlin 1:54) for Taiwanese material. Because the Japanese material agrees with that from Taiwan, MSJ adopted the name. But this name is apparently infrasubspecific according to Art. 45 of ICZN and is thus unavailable. I here provisionally treat the Japanese species as above, but further study is needed. In any case this species is rare and restricted to Iriomote Island of the Ryukyus.

The latter species, *P. pungens*, has a wide range of distribution from eastern India to Japan. This species is one of the commonest ants in southwestern Japan, nesting under stones or in rotten wood. The biology of the species was studied by Itow et al. (1984), Mizutani (1980, 1982), and Tsuji (1988a, b, c, d).

Genus **Crematogaster** Lund

(Figs. 174-184)

Crematogaster Lund, 1831, Ann. Sci. Nat. 23 : 132. Type species: *Formica scutellaris* Olivier, 1791, Encycl. Method. Histoire. Naturelle, Insectes 6 : 497, by subsequent designation of Bingham, 1903, Fauna Brit. India Hym. 2 : 124.

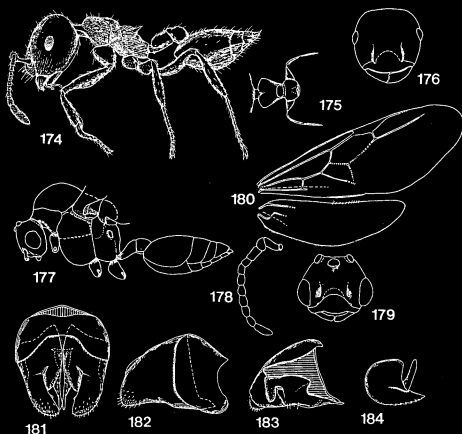
Crematogaster Agassiz, 1846, Index Univ. Nomencl. Zool. : 103 (emend.)

Acrocoelia Mayr, 1852, Verh. Zool.-Bot. Ges. Wien 2 : 146. Type species: *Acrocoelia ruficeps* Mayr, 1852, op. cit. : 147 (= *Formica scutellaris* Olivier, 1791).

Oxygyne Forel, 1901, Ann. Soc. Ent. Belg. 45 : 375 (as subgenus of *Crematogaster*). Type species: *Crematogaster (Oxygyne) daisyi* Forel, 1901, op. cit. : 376, by subsequent designation of Wheeler, 1911, Ann. N.Y. Acad. Sci. 21 : 169.

Decacrema Forel, 1910, Ann. Soc. Ent. Belg. 54 : 18. Type species: *Crematogaster schencki* Forel, 1891, Grindidier Hist. Phys. Madagascar 20 : 182, by subsequent designation of

- Wheeler, 1911, Ann. N.Y. Acad. Sci. 21 : 161.
- Atopogyne* Forel, 1911, Bull. Soc. Vaud. Sci. Nat. 47 : 342 (as subgenus of *Crematogaster*).
Type species: *Crematogaster (Atopogyne) hellanica* Forel, 1911, loc. cit., by subsequent designation of Wheeler, 1911, Ann. N.Y. Acad. Sci. 21 : 159.
- Physocrema* Forel, 1912, Mem. Soc. Ent. Belg. 14 : 220. Type species: *Crematogaster inflata* F. Smith, 1857, J. Proc. Linn. Soc. Lond. Zool. 2 : 76, by subsequent designation of Wheeler, 1913, Ann. N.Y. Acad. Sci. 23 : 82.
- Xiphocrema* Forel, 1913, Zool. Jb. Syst. 36 : 80. Type species: *Crematogaster tetracantha* Emery, 1887, Ann. Mus. Stor. Nat. Genova 25 : 467, by subsequent designation of Emery, 1922, Gen. Ins. 174 : 138.
- Eucrema* Santschi, 1918, Bull. Soc. Ent. Fr. 1918 : 182 (as subgenus of *Crematogaster*). Type species: *Formica acuta* Fabricius, 1804, Syst. Piez. 411, by original designation.
- Nematocrema* Santschi, 1918, Bull. Soc. Ent. Fr. 1918 : 182 (as subgenus of *Crematogaster*).
Type species: *Crematogaster distans* Mayr, 1870, Sitz. Ber. Akad. Wiss. Wien 61 : 402, by original designation.
- Orthocrema* Santschi, 1918, Bull. Soc. Ent. Fr. 1918 : 182 (as subgenus of *Crematogaster*).
Type species: *Myrmica sordidula* Nylander, 1849, Act. Soc. Sci. Fenn. 3 : 44, by original designation.
- Paracrema* Santschi, 1918, Bull. Soc. Ent. Fr. 1918 : 182 (as subgenus of *Crematogaster*).
Type species: *Crematogaster spengeli* Forel, 1912, Zool. Jb. Suppl. 15, vol. 1 : 56, by original designation.
- Sphaerocrema* Santschi, 1918, Bull. Soc. Ent. Fr. 1918 : 182 (as subgenus of *Crematogaster*).
Type species: *Crematogaster kneri* Mayr, 1862, Verh. Zool.-Bot. Ges. Wien 12 : 764, by original designation.
- Rhachiocrema* Mann, 1919, Bull. Mus. Comp. Zool. Harv. 63 : 318 (as subgenus of *Crematogaster*). Type species: *Crematogaster (Rhachiocrema) wheeleri* Mann, 1919, loc. cit., by original designation.
- Tranopeltoides* Wheeler, 1922, Amer. Mus. Novit. (48) : 10. Type species: *Tranopelta huberi* Forel, 1907, Hamburg. Jb. Wiss. Anst. 24 : 5, by original designation.
- Colobocrema* Wheeler, 1927, Quart. Rev. Biol. 2 : 31 (as subgenus of *Crematogaster*). Type species: *Crematogaster (Colobocrema) cylindriceps* Wheeler, 1927, loc. cit., by monotypy.
- Mesocrema* Santschi, 1928, Bull. Soc. Ent. Belg. 68 : 33 (as subgenus of *Crematogaster*). Type species: *Crematogaster rasoherinae* Forel, 1891, Grandidier Hist. Phys. Madagascar 20 : 182, by subsequent designation of Donisthorpe, 1943, Ann. Mag. Nat. Hist. 11 (10) : 661.
- Apterocrema* Wheeler, 1936, Psyche 43 : 45. Type species: *Apterocrema atillani* Wheeler, 1936, loc. cit., by monotypy.



Figs. 174-184. *Crematogaster* spp., (174-176, worker; 177-179, 181-184, male; 180, female): 174, *C. brunnea teranishii*, profile; 175, same, petiole and postpetiole; 176, same, head; 177, *C. sp.*, profile; 178, same, right antenna; 179, same, head; 180, *C. laboriosa*, right wings; 181, *C. sp.*, male genitalia, ventral view; 182, same, lateral view; 183, same, left paramere; 184, same, right aedeagus.

Worker : Head subrectangular or rounded, sides usually convex; occipital carina indistinct. Mandibles small and narrow, partially covered by anterior margin of clypeus when closed; masticatory margin with 3 to 5 teeth; masticatory axis forming almost at right angles to long axis of head. Palp formula 5,3 in Japanese species (rarely 4,3 in exotic species). Clypeus narrow, straight or broadly rounded anterior margin. Frontal carinae short or indistinct, anteriorly forming frontal lobes which cover antennal insertions. Antennae 11-segment in Japanese species (or 10-segmented in some exotic species); scape usually short, at most slightly exceeding posterior corners of head; apical portion of funiculus forming 2-, 3-, or 4-segmented club, or not forming club. Eyes medium, situated at or just behind the midlength of sides of head.

Trunk shortened; promesonotal area raised, with indistinct suture; metanotal groove

distinct; propodeal spine varying from completely absent to acute process (at least all Japanese species bearing more or less developed spine); propodeal spiracle situated well posteriorly, just below the base of propodeal spine. Ventral processes absent on meso- and metasternum. Legs short; middle and hind tibial spurs indistinct. Petiole depressed, more or less produced laterally, without node; subpetiolar process present or absent. Postpetiole with rounded node which often bears median impressed line; posteriorly attached to dorsal portion of gaster. Gaster triangular in dorsal view. Sting spatulate.

Female: General form of head as in worker with larger eyes and distinct ocelli. Trunk massive; pronotum overhung by mesoscutum; mesonotum elongate, swollen and arched dorsally; notauli absent, parapsidal furrows indistinct; mesoscutellum not overhanging metanotum; propodeal spine less distinct than that of worker; propodeal spiracle situated forward, apart from posterior margin. Fore wing venation varying from type II to type IV; usually veins and stigma weakly developed; m-cu present or absent; radial cell open. Remainder of body and appendages like those of worker.

Male: Head subglobose; as long as or slightly shorter than broad excluding eyes; occipital carina low. Mandibles narrow and small; masticatory margin dentate. Palp formula 4,3 in Japanese species. Clypeus projecting anteriorly; anterior margin almost straight. Frontal carinae not developed. Antennal insertions exposed, close to posterior margin of clypeus. Antennae 12-, 11-, or 10-segmented; scape short and thick; second antennal segment globose; funiculus filiform. Eyes large and prominent. Ocelli well developed.

Trunk massive; pronotum overhung by mesoscutum; mesonotum large, convex; notauli absent, parapsidal furrows present; mesoscutellum overhanging metanotum; propodeum vertical, without paired spines; propodeal spiracle large, situated apart from posterior margin of propodeum. Fore wing as in female. Legs slender; middle and hind tibiae each with small apical spur. Remainder of body as in female.

Hypopygium broad, subtriangular. Genital capsule small; basal ring thick; paramere shortened with small gonocoxal arm and rounded apex; volsella with digitus and cuspis, both thin and lamelliform; aedeagus broadened basally in dorsal view; aedeagal plate with serrate ventral margin and rounded apical portion.

This is one of the largest genera of ants, including more than 400 described species. It occurs in almost all the zoogeographical regions, mostly found in the warmer part of the world. But the taxonomy of the genus is far from complete. Some species are arboreal, others nest under stones.

In Japan, nine names were listed by Onoyama (1980) but actually MSJ (1988) recognized the occurrence of seven species: two are undetermined and the following five are named species:

Crematogaster brunnea teranishii Santschi

- C. laboriosa* F. Smith
C. matsumurai Forel
C. matsumurai vagula Wheeler
C. osakensis Forel

The following names have been questioned by MSJ for their status: *C. brunnea ruginota* var. *azumai* Santschi; *C. laboriosa* var. *nawai* Ito; *C. matsumurai* var. *iwatensis* Santschi.

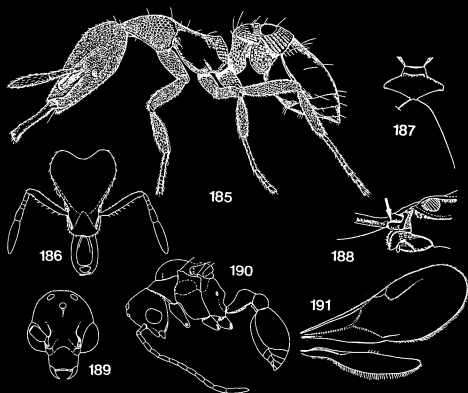
Genus **Strumigenys** F. Smith

(Figs. 185-191)

- Strumigenys* F. Smith, 1860, J. Ent. 1 : 72. Type species: *Strumigenys mandibularis* F. Smith, 1860, loc. cit., by monotypy.
Labidogenys Roger, 1862, Berlin. Ent. Zeit. 6 : 249. Type species: *Labidogenys lyroessa* Roger, 1862, op. cit.: 251, by monotypy.
Pyramica Roger, 1862, Berlin. Ent. Zeit. 6 : 251. Type species: *Pyramica gundlachi* Roger, 1862, op. cit.: 253, by monotypy.
Proscopomyrmex Patrizi, 1946, Boll. Ist. Ent. Univ. Bologna 15 : 294. Type species: *Proscopomyrmex londianensis* Patrizi, 1946, op. cit., by monotypy.
Eneria Donisthorpe, 1948, Ann. Mag. Nat. Hist. (11) 12 : 598. Type species: *Eneria excisa* Donisthorpe, 1948, loc. cit., by original designation.

Worker: Head cordiform; posterior margin deeply emarginate in the middle with two occipital lobes; occipital carina low. Mandibles narrow, linear, usually elongate; mandibular shaft basally bearing inner projection which is completely covered by clypeal apron; preapical portion usually bearing tooth; apical most portion (masticatory margin) vertical, armed with dorsal and ventral teeth. Palp formula 1,1. Labrum constricted basally, with lateral projections and paired long hairs. Clypeus projecting over basal portion of mandibles, forming flat apron which has straight anterior margin and rounded corners. Frontal carinae distinct, with vertical antennal scrobes. Frontal lobes covering antennal insertions. Antennae 6-segmented; scape flat, rather slender in all Japanese species; third and fourth antennal segments small; apical 2 segments elongate, forming antennal club. Eyes small to medium, situated at ventral margin of antennal scrobes.

Trunk slender; promesonotal area more or less raised, without distinct suture; metanotal groove indistinct; propodeal spines present or absent; posterior portion of propodeum often marginate with lamelliform appendage; propodeal spiracle situated posterodorsally, close to posterior margin. Hair wheel present. Ventral processes absent on meso- and metasternum. Legs slender; middle and hind tibiae lacking distinct apical



Figs. 185-191. *Strumigenys lewisi*, (185-188, worker; 189-191, male): 185, profile; 186, head; 187, labrum (right trigger hair partly omitted); 188, mouth parts, lateral view, arrow indicating labrum (left mandible removed); 189, head; 190, profile; 191, right wings.

spurs. Petiole nodiform or claviform; node usually low and rounded; subpetiolar process absent. Postpetiole with broad elliptical node. Spongiform appendages well developed ventrally and laterally on both petiole and postpetiole. Sting developed.

Hairs on body and appendages often modified to spatulate, clavate or distinctly elongate.

Female: General form of head as in worker, with larger eyes and small ocelli. Trunk massive; pronotum not overhung by mesoscutum; notauli absent, parapsidal furrows present but often indistinct; mesoscutellum overhanging metanotum; propodeum vertical, with less developed spines. Fore wing with type IV venation; stigma small and obscure; m-cu absent; radial cell open; hind wing narrow, lacking veins. Remainder of body and appendages like those of worker.

Male: Head subtriangular; posterior margin rounded; occipital carina low. Mandibles small and narrow, non-opposable; apex acute; outer margin convex. Labrum broad and concave anteriorly. Mouth parts not dissected. Clypeus raised posteromedially, flattened

anteriorly ; anterior portion projecting over basal portion of mandibles and forming apron which has straight or widely rounded anterior margin. Frontal carinae short but distinct, without antennal scrobes. Antennal insertions exposed, situated apart from posterior margin of clypeus. Antennae 13-segmented ; scape thick and short ; funiculus filiform. Eyes large and prominent. Ocelli developed.

Pronotum not overhung by mesoscutum ; median furrow, notauli and parapsidal furrows impressed on mesoscutum ; mesoscutellum convex dorsally, overhanging metanotum ; hair wheel indistinct ; propodeum vertical, without projections posteriorly ; propodeal spiracle situated apart from posterior margin of propodeum. Fore and hind wings like those of worker. Ventral processes absent on meso- and metasternum. Legs slender ; middle and hind tibiae each with small apical spur. Petiole clavate, with anterior peduncle ; node lower and more rounded than that of worker ; subpetiolar process absent. Postpetiole subglobose. Spongiform appendages rudimentary, weakly developed on ventral surface on petiole and posterior margin of postpetiole. Genitalia not dissected.

This genus includes about 160 described species, distributing the warmer part of the World (Bolton, 1983). The ant is one of the largest genera within the tribe Dacetini which comprises 29 genera and is characterized by having a the cordiform head with distinct antennal scrobes, the fewer number of antennal segments (4 or 6 segments), the broad and shield-like clypeus, and the spongiform appendage on the petiole and postpetiole. The following 6 genera of this paper, *Quadristruma*, *Smithistruma*, *Pentastroma*, *Trichoscapa*, *Kyidris* and *Epitritus* are also members of tribe Dacetine. All these 7 genera occurring in Japan belong to the subtribe Strumigeniti which has the largest number of composing genera (22 genn.), compared with other 3 subtribes (Dacetinitini, Orectognathini, and Epopostrumiti). The ants of this tribe are predators of soil arthropods. The biology of the tribe were revised by Brown & Wilson (1959).

In his important series of the taxonomy of dacetines, Brown revised for Neotropical (1962), and some of Asian species (1949, 1953, 1954b, 1957, 1958, 1971a, 1973b). Bolton also gave a revision of Afrotropical species (1983).

In Japan at least 3 described species have been known to occur :

Strumigenys lewisi Cameron

S. minutula Terayama & Kubota

S. solifontis Brown

As pointed out by Onoyama (1976), Sonobe (1977), and Masuko & Terayama (1984) there are several additional species which can be distinguished by the shape of trunk in females in Japan. The taxonomic treatment of these has not been done.

The Predatory behavior of the Japanese species were revised by Masuko (1984).

Genus **Quadristruma** Brown

(Figs. 192-193)

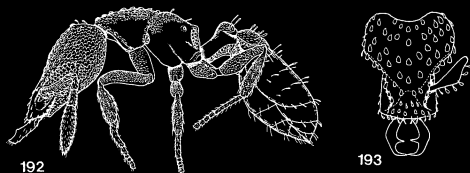
Quadristruma Brown, 1949, Trans. Amer. Ent. Soc. 20 : 47. Type species : *Epitritus emmae* Emery, 1890, Bull. Soc. Ent. Ital. 22 : 70, by original designation.

Worker : Head cordiform ; posterior margin emarginate in the middle ; occipital carina low. Mandibles short, liner, curved mesally ; mandible insertions rather close to each other ; apical portion with 2 acute teeth vertically ; subapical portion with distinct tooth. Basal lobe of mandible small, directed posteriorly ; labrum with indistinct lateral lobes (Brown, 1949). Clypeus projecting forward, forming flat squariform apron which covers basal portion of mandibles. Frontal carinae distinct with vertical antennal scrobes. Frontal carinae covering antennal insertions. Antennae 4-segmented ; scape flattened, broadest at the midlength ; constriction between second and third antennal segments distinct ; apical segment longest, longer than 2 preceding segments together. Eyes small, situated at ventral margin of antennal scrobes.

Trunk flattened dorsally ; pronotum marginate anteriorly ; promesonotal suture indistinct ; hair wheel distinct ; metanotal groove weakly impressed ; posterior portion of propodeum marginate with lamelliform appendage. Ventral processes absent on meso- and metasternum. Legs short and robust ; middle and hind tibiae without apical spurs. Petiole clavate ; node low and rounded ; subpetiolar process absent. Postpetiole with broad node. Spongiform appendage well developed ventrally and dorsally on petiole and postpetiole. Sting developed.

Dorsum of head with orbicular hairs ; clavate hairs present on body and legs.

Female (dealate) : Head as in worker, with larger eyes and small but distinct ocelli. Pronotum marginate anteriorly with rounded humeri. Mesonotum thin ; mesoscutum not



Figs. 192-193. *Quadristruma emmae*, worker : 192, profile ; 193, head.

overhanging pronotum; notauli absent, parapsidal furrows indistinct; mesoscutellum overhanging metanotum. Propodeum with short dorsal surface; propodeal spine short but distinct; lamelliform appendage on posterior margin distinct. Remainder of body and appendages as in worker.

Male: Unknown to me.

The genus comprises only 2 species: *Q. eurycera* (Emery) and *Q. emmae* (Emery). The former is restricted to New Guinea. The latter has wide range of distribution, occurring in the warmer parts of the world, but native to Afrotropical region (Bolton, 1983).

In Japan, the following species has been recorded from the Ogasawara Island and the Ryukyus but is rare in both areas:

Quadristruma emmae (Emery)

Genus **Smithistruma** Brown

(Figs. 194-201)

Cephaloxys F. Smith, 1865, Jour. Linn. Soc. Lond. 8 : 76. Type species: *Cephaloxys capitata* F. Smith, 1865, op. cit.: 77, by monotypy. [Nom. preoc., nec. Signoret, 1847 : 294 — Hemiptera.]

Smithistruma Brown, 1948, Trans. Amer. Ent. Soc. 74 : 104. Type species: *Strumigenys pulchella* Emery, 1895, Zool. Jb. Syst. 8 : 327, by original designation.

Wessonistruma Brown, 1948, Trans. Amer. Ent. Soc. 74 : 106 (as subgenus of *Smithistruma*). Type species: *Strumigenys pergandei* Emery, 1895, Zool. Jb. Syst. 8 : 326, by original designation.

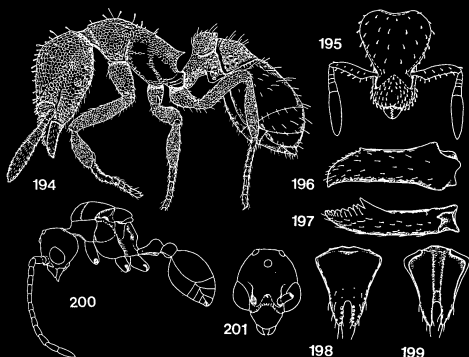
Weberistruma Brown, 1948, Trans. Amer. Ent. Soc. 74 : 106 (as subgenus of *Smithistruma*). Type species: *Strumigenys* (*Cephaloxys*) *leptothrix* Wheeler, 1929, Boll. Lab. Zool. Gen. Agr. Ist. Portici 24 : 55, by original designation.

Weberistruma Brown; Brown, 1949, Mushi 20 : 7. (Raised to genus).

Micostruma Brown, 1948, Trans. Amer. Ent. Soc. 74 : 123. Type species: *Epitritus mandibularis* Szabó, 1909, Arch. Zool. 1:1, by original designation.

Platystroma Brown, 1953, Amer. Midl. Nat. 50 : 112 (as subgenus of *Smithistruma*). Type species: *Strumigenys* (*Cephaloxys*) *depressiceps* Weber, 1934, Rev. Ent. 4 : 47, by original designation.

Worker: Head cordiform, more or less convex dorsally; posterior margin excised in the middle; occipital carina low. Mandibles short; dorsal surface more or less convex, but not forming transverse dorsal ridge; masitatory margin serially dentate, consisting



Figs. 194-201. *Smithistruma incerta*. (194-199, worker; 200-201, male): 194, profile; 195, head; 196, left mandible, lateral view; 197, same, dorsal view; 198, labrum, dorsal view; 199, same, ventral view; 200, profile; 201, head.

of 12-17 teeth and basal lamella. Palp formula 1,1 or 1,0. Labrum longer than broad, with apical paired lobes. Clypeal apron projection over basal portion of mandibles, varying in shape with species. Frontal carinae distinct, with vertical antennal scrobes. Frontal lobes covering antennal insertions. Antennae 6-segmented; scape more or less flat, sometimes distinctly broadened at basal portion; third and fourth antennal segments small; apical segment longest. Eyes medium to small, situated at ventral margin of antennal scrobes.

Trunk varying in shape with species, from depressed to convex dorsally; pronotum with or without anterior margination; promesonotal suture indistinct or absent dorsally; metanotal groove weakly impressed or completely absent; propodeal spine usually present as small tooth; propodeal spiracle situated posterodorsally, close to posterior margin; lamelliform appendage on posterolateral portion of propodeum present. Ventral processes absent on meso- and metasternum. Middle and hind tibiae without apical spurs. Petiole usually claviform, with anterior peduncle; subpetiolar process absent. Postpetiole broad, with elliptical node. Spongiform appendage well developed ventrally and laterally on petiole and postpetiole. Sting developed.

Hairs often modified to clavate, spatulate or distinctly long.

Female: General form of head as in worker, with larger eyes and small ocelli. Pronotum sometimes marginate anteriorly with distinct humeri; mesoscutum not overhanging pronotum; notauli absent, parapsidal furrows present; mesoscutellum overhanging metanotum; propodeal spines less developed; posterior lamelliform appendage on propodeum more abundant than that of worker; propodeal spiracle situated well forward to posterior margin of propodeum. Fore wing with type IV venation; stigma small and obscure; m-cu absent; radial cell open; hind wing narrow with long marginal hairs.

Remainder of body and appendages like those of worker.

Male: Head subglobose-subtriangular; occipital carina low. Mandibles small, subtriangular; masticatory margin edentate, with acute apex. Anterior margin of labrum with paired lobes which are less developed than those of worker. Mouth parts not dissected. Clypeus convex in the middle; anterior margin rounded, projecting over basal portion of mandibles. Frontal carinae short, without distinct scrobes. Frontal lobes not covering antennal insertions which are situated apart from posterior margin of clypeus. Anterior margin of antennal insertions forming raised carinae. Antennae 13-segmented; scape short and thick, cylindrical in cross section; funiculus filiform. Eyes large and prominent, inner margin straight. Ocelli well developed.

Pronotum not marginate anteriorly, overhung by mesoscutum; mesoscutum with deeply impressed median paired furrows, notauli and parapsidal furrows; mesoscutellum convex dorsally, overhanging metanotum; hair wheel indistinct; propodeal spine absent or weakly developed; propodeal spiracle situated posterodorsally, apart from posterior margin of propodeum; lamelliform appendage on propodeum less developed. Ventral processes absent on meso- and metasternum. Legs long and slender; middle and hind tibiae without apical spurs. Petiole with slender anterior peduncle; node low and rounded; subpetiolar process absent. Postpetiole subglobose; node broader than that of petiole. Spongiform appendage almost absent, only rudimentally developed on ventral margin of petiole.

Hairs less specialized than those of worker. Genitalia not dissected.

This genus comprises about 100 species, widely distributed in the world except in the Australian and Malagasy regions (Bolton, 1983). Since Brown (1948) gave a definition of the genus, many additional species which link other genera have been described. As a result the limit of the genus has become obscure. All the character demarcating the genus seem to be plesiomorphic within the Dacetini. Thus reconsideration of the phylogeny of whole smithistumiform genera is needed to redefine the genus.

In Japan Onoyama (1980) listed 3 species of the genus, one of which was under the name *Weberistruma*. MSJ distinguished 8 species, 4 of which are undetermined. At least the following 4 species has been know to occur in Japan:

Smithistruma incerta Brown

S. japonica (Ito)

S. leptothrix (Wheeler)

S. rostrataeformis Brown

All the species listed above are rather rare, nesting in the soils or rooten woods of broadleaved forests. A brief observation on the predatory behavior of some species was reported by Masuko (1981, 1985).

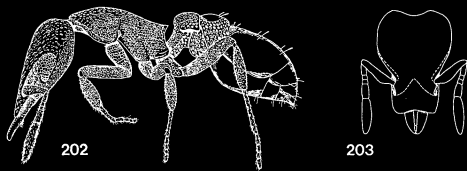
Genus **Pentastruma** Forel

(Figs. 202-203)

Pentastruma Forel, 1912, Ent. Mitt. Berlin 1 : 50. Type species: *Pentastruma sauteri* Forel, 1912, loc. cit., by monotypy.

Worker: Head cordiform with flattened dorsum; posterior margin emarginate in the middle; occipital carina low. Mandibles narrowly subtriangular, depressed; masticatory margin with 10-15 small and acute teeth and rounded basal lamella. Palp formula 1,1. Labraum elongate, with two distinct lobes apically. Clypeus with median tumulus, projecting over basal portion of mandibles, forming flat and broad apron; anterior margin more or less concave in the middle. Frontal carinae distinct with vertical antennal scrobes. Frontal lobes covering antennal insertions. Anterior portion just below antennal insertion forming distinct thin lateral ridge. Antennae 6-segmented; scape flattened; third and fourth antennal segments small, apical segment longest. Eyes small, situated at ventral margin of antennal scrobes.

Trunk flattened dorsally; pronotum strongly marginate anteriorly; promesonotal suture absent dorsally; hair wheel more or less distinct; metanotal groove weakly



Figs. 202-203. *Pentastruma canina*, worker: 202, profile; 203, head.

impressed; propodeum with dentiform projection posterodorsally; posterior portion of propodeum marginate with lamelliform appendage. Propodeal spiracle situated dorsally. Ventral processes absent on meso- and metasternum. Middle and hind tibiae without apical spurs. Petiole clavate with narrow anterior peduncle; subpetiolar process absent. Postpetiole with broad elliptical node. Spongiform appendage distinct ventrally and laterally on petiole and postpetiole. Sting well developed.

Head, trunk, legs and petiole lacking erect hairs; postpetiole and gaster with clavate hairs.

Female (dealate): General form of head as in worker, with larger eyes and small ocelli. Pronotum marginate anteriorly, flattened dorsally, with angulate humeri; mesoscutum not overhanging pronotum; notauli absent, parapsidal furrows indistinct; mesoscutellum overhanging metanotum; propodeum with dentiform projection posterodorsally, and with vertical posterior face which is marginate with lamelliform appendage on both sides. Remainder of body and appendages like those of worker.

Male: Unknown to me.

The genus comprises 2 species, and is restricted to Japan and Taiwan. The revision of the genus includes that of Brown & Boisvert (1978).

Both the species constituting the genus are found in Japan:

Pentastruma canina Brown & Boisvert

P. sauteri Forel

The former species is found in southwestern Japan and is rare, nesting in the soil of broadleaved forest floors. The latter species was originally described from Taiwan and was recently reported from the Ryukyus, Japan (Terayama, 1985c). The predatory behavior of *P. canina* was reported by Masuko (1981, 1984, 1985).

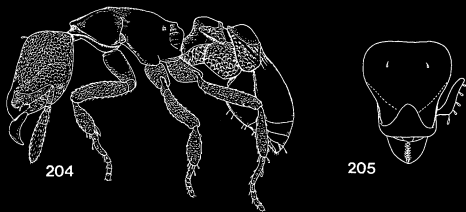
Genus **Trichoscapa** Emery

(Figs. 204-205)

Trichoscapa Emery, 1869, Ann. Acad. Aspr. Nat. 2 : 24 (as subgenus of *Strumigenys*). Type species: *Strumigenys* (*Trichoscapa*) *membranifera* Emery, 1869, loc. cit., by monotypy.

Trichoscapa Emery; Brown, 1948, Trans. Amer. Ent. Soc. 74 : 112. (Raised to genus).

Worker: Head cordiform; posterior margin excised in the middle; occipital carina low. Mandibles subtriangular with convex dorsal surface, and with distinct basal border which forms distinct transverse gap for anterior margin of clypeus when mandibles are closed; masticatory margin with serially dentate which consists of 12 small teeth and a basal



Figs. 204-205. *Trichoscapa membranifera*, worker: 204, profile; 205, head.

lamella. Palp formula 1.0. Labrum not dissected. Clypeus flattened anteriorly, slightly convex posteromesally; anterior portion projecting over basal portion of mandibles, forming squariform apron. Frontal carinae distinct with vertical antennal scrobes. Frontal lobes broad, covering antennal insertions. Antennae 6-segmented; scape short and flattened, broadest at basal 1/3 of its length; apical segment long. Eyes small, situated at ventral margin of antennal scrobes.

Pronotum marginate anteriorly and laterally, forming squariform flat dorsum, with right angled humeri; promesonotal suture indistinct; hair wheel present; metanotal groove absent; propodeal declivity marginate on both sides with distinct lamelliform appendage. Ventral processes absent on meso- and metasternum. Legs robust; middle and hind tibiae without distinct apical spurs. Petiole claviform without subpetiolar process. Postpetiole with broad elliptical node. Spongiform appendage abundant ventrally and laterally on petiole and postpetiole. Sting developed.

Hairs sparse; erect clavate hairs present on vertex of head, antennal scape, legs and gaster.

Female: General form of head as in worker, with larger eyes and distinct ocelli. Pronotum marginate anteriorly with angulate humeri, not overhung by mesoscutum; notauli absent, parapsidal furrows indistinct; mesoscutellum overhanging metanotum; posterolateral margin of propodeum with lamelliform appendage; propodeal spiracle situated apart from posterior margin of propodeum. Fore wing with type IV venation; stigma small and obscure; m-cu absent; radial cell open; hind wing narrow, lacking veins. Remainder of body and appendages like those of worker.

Male: Unknown to me.

The genus comprises a single species, *Trichoscape membranifera* Emery, which is widely distributed in the warmer parts of the world and is native to Africa (Brown, 1949).

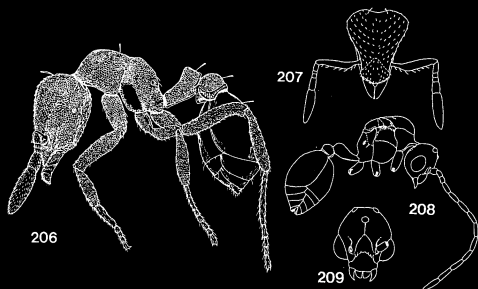
In Japan, the species is rare and found in southern area, nesting in the soil of rather open land.

Genus *Kyidris* Brown

(Figs. 206-209)

Kyidris Brown, 1949, Mushi 20 : 3. Type species: *Kyidris mutica* Brown, loc. cit., by monotypy.

Worker: Head subtriangular; posterior margin concave in the middle with low occipital carina; mandibles short, subtriangular; masticatory margin serially dentate, consisting of rounded basal lamella and apical series of small denticles which are separated by diastema. Mouthpart not dissected. Clypeus depressed; anterior margin broadly rounded, projecting over basal portion of mandibles, but not forming distinct lateral apron. Frontal carinae straight, with vertical antennal scrobes. Frontal lobes covering antennal insertions. Antennae 6-segmented; scape flattened, not reaching posterior corner of head; third and fourth antennal segments small; apical segment



Figs. 206-209. *Kyidris mutica*, (206-207, worker; 208-209, male): 206, profile; 207, head; 208, male; 209, head.

longest. Eyes small, situated at posterior ventral margin of antennal scrobes.

Trunk shortened; pro- and mesonotum fused together, forming a single rounded convexity; promesonotal suture absent; hair wheel between pronotum and mesepisternum small; metanotal groove impressed; propodeum arched dorsally with rounded postero-dorsal corners, without dentiform projections; lamelliform appendage on posterolateral margin of propodeum less developed; propodeal spiracle situated near to posterior margin of propodeum. Ventral processes absent on meso- and metasternum. Legs short and stout; middle and hind tibiae without apical spurs. Petiole claviform; with anterior peduncle and low node; subpetiolar process absent. Postpetiole transverse, with elliptical node. Spongiform appendage weakly developed on both petiole and postpetiole.

Erect or suberect clavate hairs present on dorsal surface of body, but sparse.

Female: General form of head as in worker, with larger eyes and small ocelli. Trunk short; pronotum not overhung by mesoscutum, without distinct humeri; mesoscutum convex dorsally; notauli absent, parapsidal furrow present; mesoscutellum overhanging metanotum; propodeum with vertical posterior face, without lamelliform appendage posterolaterally; propodeal spiracle situated dorsally, apart from posterior margin of propodeum. Fore wing with type IV venation; hind wing narrow with long marginal hairs. Spongiform appendage on petiole and postpetiole weakly developed. Remainder of body less developed.

Male: Head subglobose, compressed dorsoventrally, longer than broad; posterior portion broader; occipital carina low. Mandibles small, subtriangular blade-like form but non-opposable; apex acute. Labrum with two apical lobes. Palpi not dissected. Clypeus rather long, convex in the middle, with rounded anterior margin. Frontal carinae indistinct. Antennal insertions exposed. Frontal area impressed. Antennae 13-segmented; scape short, almost as long as second or third antennal segment; funiculus filiform. Eyes large and prominent; inner margin not concave. Ocelli developed.

Pronotum overhung by mesoscutum; mesonotum thick, convex dorsally; notauli absent, parapsidal furrows deeply impressed on mesoscutum; mesoscutellum overhanging metanotum; propodeum with blunt posterodorsal corners, but not forming projections; posterior portion of propodeum not marginate. Fore and hind wings as in female. Middle and hind tibiae without apical spurs. Petiole and postpetiole like those of worker, but without spongiform appendages. Genitalia not dissected.

The genus consists of 3 species: 2 in New Guinea, 1 in Japan and Taiwan. The biology of the genus was revised by Wilson & Brown (1965). According to them, both the New Guinean species are parasites of *Strumigenys loriae* and the Japanese species has also the possibility of a temporary social parasite.

In Japan the genus has been known as a single species:

Kydris mutica Brown

Although there has been no direct evidence of the social parasitism in the Japanese species, Mr. F. Ito and I found a dealate female of *K. mutica* in the colony of *Strumigenys lewisi* (collecting data: Kuroda, Matsue City, Shimane Pref., 13.ix.1985). This supports the hypothesis of Wilson & Brown (1965).

Genus **Epitritus** Emery

(Figs. 210-216)

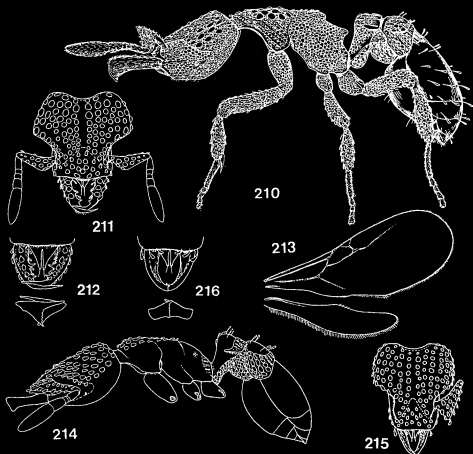
Epitritus Emery, 1869, Bull. Soc. Ent. Ital. 1 : 136. Type species: *Epitritus argiolus* Emery, 1869, loc. cit., by monotypy.

Worker: Head cordiform; posterior portion broad, somewhat squariform with concave posterior margin and rounded posterior corners; occipital carina low; median portion of head abruptly narrowed. Mandibles narrow, linear but short, strongly curved to midline; mandibular insertions more or less widely separated from each other; apically lacking forked spiniform teeth, but with a single acute tooth dorsally, or with a series of denticles on vertical masticatory margin; preapical teeth on mandibular shaft present or absent; basal lamella low, bluntly angulate. Palp formula 1.0. Labrum longer than broad, with paired lobes apically. Clypeus flattened, projecting anterolaterally, forming squariform apron which covers basal portion of mandibles. Frontal carinae distinct with vertical antennal scrobes. Frontal lobes covering antennal insertions. Antennae 6- or 4-segmented; scape flattened, often distinctly broadened at basal 1/3 of its length, not reaching posterior corners of head; constriction between second and third antennal segment distinct; apical segment long. Eyes small, situated at ventral margin of antennal scrobes.

Trunk depressed dorsally, broadest at anterior portion; pronotum marginate anteriorly; promesonotal suture indistinct; hair wheel between pronotum and mesepisternum present; metanotum often present as weakly produced strip between mesonotal area and propodeum, sometimes overhanging propodeum; metanotal groove present or absent; propodeal spine present or absent; lamelliform appendage on posterior lateral margin of propodeum variously developed with species; propodeal spiracle situated on dorsolateral portion. Ventral processes absent on meso- and metasternum. Legs robust; middle and hind tibiae without apical spurs.

Petiole clavate, with narrow anterior peduncle; subpetiolar process absent. Postpetiole distinctly broader than postpetiole, with elliptical node. Spongiform appendage well developed ventrally and laterally on both petiole and postpetiole. Sting developed.

Orbicular hairs present on dorsa of head and trunk; clavate hairs also present on legs,



Figs. 210-216. *Epitritus* spp. (210-212, 214-215, worker; 213, female): 210, *E. hexamerus*, profile; 211, same, head; 212, same, mandibles, dorsal view (upper) and apical dentition (lower); 213, same, right wings; 214, *E. hirashimai*, profile (from Ogata, 1990); 215, same, head (from Ogata, 1990); 216, same, mandibles, dorsal view (upper) and apical dentition (lower) (from Ogata, 1990).

trunk, petiole, postpetiole and gaster.

Female: General form of head as in worker, with larger eyes and distinct ocelli. Pronotum marginate anteriorly, with distinct humeri; mesonotum not overhanging pronotum; notauli absent, parapsidal furrows present; mesoscutellum overhanging metanotum. Fore wing venation type IV; stigma small and obscure; m-cu absent; radial cell open; hind wing narrow, without veins, but with long marginal hairs. Remainder of body and appendages like those of worker.

Male: Unknown to me.

The genus consists of 8 species; 4 in Africa, 1 in Europe, and 3 in Asia. Bolton (1983) revised Afrotropical species. The taxonomy of Asian species was studied by Brown (1958) and Taylor (1968b). The genus has been represented by 2 species in Japan:

Epitritus hexamerus Brown

E. hirashimai Ogata

The species are distinguished by the teeth of mandibles and shape of trunk (Ogata, 1990). Both the species are rare, nesting in soils of broadleaved forest floor. Masuko (1981, 1984, 1985) reported a predatory behavior of *E. hexamerus*.

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